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FORTY-FIFTH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY

December 31, 1930, to January 3, 1931

By RAYMOND S. DUGAN.

After the thirty-ninth meeting in 1927 Professor Schlesinger remarked to the writer that the meeting had been no trouble at all and that he would be glad to have the Society come to New Haven as often as it wanted to. Had it not been for this assurance the Society might have felt it somewhat of an imposition to return after only three years. The sessions for papers were held in the same room in Harkness Hall; we gathered for luncheon and dinner and social converse in the Faculty club; and most of us returned again to dormitory life. It was all very familiar and comfortable with no interruption of complete astronomical communion.

The number of authors who could not decide, before the program was printed, whether they were going to give papers was about as usual, that is, one-half the total number of those who finally presented papers. The Council gathered at the Faculty club on New Year's Eve, took the program apart and put it together again, and then elected twelve new members to the Society, bringing the total to 522.

Thirty-eight papers were given in five sessions. As the Society has decided to issue its own publications I shall try to give to the readers of POPULAR ASTRONOMY a brief summary of some of the papers.

E. W. Brown read a paper by A. L. Loomis and one by himself and Dirk Brouwer, describing the mechanism of the precision chronograph invented by Loomis and an analysis of the record of three Shortt clocks. The chronograph makes a variation of one one-thousandth of a second readily visible as a linear displacement of about one-tenth of an inch. Frank Schlesinger and Ida Barney described the success with which the positions and proper motions in the Yale catalogues have been used in a new reduction of some of the Astrographic zone plates. As the probable errors of the positions are reduced by one-half it appears to be worth while to carry out the reductions for all the plates in the zones covered by the Yale observations. Plates are now being made at Yale which cover 150 square degrees, contain a sufficient number of catalogue stars for their reduction, and yield positions comparable in accuracy with those obtained from the smaller plates. S. G. Barton was the harbinger of the good news that the labor of a least-squares solution might be reduced by certain arrangements of the computation. G. H. Draper gave some explanation of his notions of time and space.

The success of the expedition to observe the eclipse of October 21, 1930, at Niuafou was evident from the slides shown by R. W. Marriott and J. H. Pitman. The discomforts and engineering feats of the observers were all comfortably enjoyed by the audience at the movies conducted by Weld Arnold on Thursday evening.

There were three papers on Eros: Frederick Slocum and C. L. Stearns have solved the difficulty which the motion of Eros presents, by breaking the trail up into segments. A small quadrant occults Eros periodically. All times are recorded automatically. Margaret Harwood reported on her photographic observations and showed that the amplitude of light variation was greater in December than it was in October. Leon Campbell has compared the observations of Wendell and Bailey in 1900 and 1905 with recent observations and has found a mean period of rotation of $5^h\,16^m\,12^s.92$.

There were likewise three papers on Pluto: C. O. Lampland sent in a paper on the discovery and observation of Pluto, the measurement of plates and the calculation and improvement of orbits, and, with the aid of new ephemerides, the finding of the planet on two plates taken in 1915. S. B. Nicholson and N. U. Mayall have determined the mass of Pluto from perturbations of Neptune as 1.0 ± 0.3 times the mass of the earth. C. H. Smiley drew attention to the possibility of computing an ephemeris sufficiently accurate for finding purposes even when some of the orbital elements are indeterminate.

W. J. Fisher reviewed the records of the annual showers of Leonid meteors.

Sten Asklof, as a result of his computations on the definitive orbit of comet 1917 I, thinks that visual and photographic observations should not be combined in studying the motion of comets. A probable case of identification of a comet and an asteroid was considered by Joe Ueta, of Kyoto Observatory. Alexander Vyssotsky has made a careful observational study of the apparent photovisual magnitude of the companion of Sirius and finds 6.9. This makes the star about 1½ magnitudes brighter than formerly assumed.

L. V. Robinson reported on the study of light curves of Cepheids from Harvard plates. He finds a significant relation between the period and the fraction of the period between maximum and minimum. He also finds that for all stars the rate of radiation per unit mass depends almost wholly on the density.

Four papers dealt with color indices: Joel Stebbins gave an account of his use of filters with the photo-electric cell to determine color indices leading to information concerning the temperatures of stars and the absorption in space. Miss Lois Slocum told of her work at the Lick Observatory in determining the color indices of 1500 faint stars in Cassiopeia and Cygnus regions, the coefficient of selective absorption, and the star density. Miss Cecilia Payne reported on the determination of photo-visual magnitudes of stars to the eleventh magnitude in the Harvard Standard Regions. A paper sent in by V. M. Slipher called

attention to the rapidity with which color index data for large numbers of faint stars may be obtained by the use of a yellow isochromatic plate with an objective corrected for the actinic rays.

J. Q. Stewart and R. B. King considered the probable nature of the material of dark nebulae, the masses involved, and the evidence which might be found in the appearance of the nebulae and in the spectra and motion of stars near them.

P. van de Kamp has worked over the material on globular clusters, on Harvard Milky Way Field 185, and on the rotation of the galaxy, with allowance for absorption, and considers a distance to the galactic center of about 12,000 parsecs as a fair compromise. S. A. Korff explained his experimental procedure in obtaining absolute contours of the D-lines of sodium in absorption, which should give a method for the quantitative analysis of vapors, with application to the constitution of stellar atmospheres. P. A. Millman reviewed the methods devised for the determination of radial velocities from objective prism plates, and told of the increased accuracy obtained by the use of a comparator.

There were several papers on solar and stellar spectroscopy: Charlotte Moore has estimated the intensities of about 6000 lines in the sun-spot spectrum; has revised and extended the identification of the solar lines; and has developed the quantitative determination of the composition of the atmosphere above the spots. The temperature of the spot is found to be $4720° \pm 40°$, and the quantity of material in the atmosphere above the spot 1.7 ± 0.11 times greater than that above an equal area of the disk. R. W. B. Pearse has established the presence of SiH in sun spots; while R. S. Richardson has found definite evidence of the presence of SiF, AlO, AlH, and ZrO.

Spectrograms of Eta Aquilae, according to C. J. Krieger, show that the temperature variation of this star is of the order of 3000°. Otto Struve finds that certain absorption lines of helium in stellar spectra are frequently much fainter than they should be on theoretical grounds and concludes that there are at work in the stars physical factors which have not as yet been taken into account. He also suggests that the bright lines in the spectra of B-type stars originate in nebulous rings which have been formed around the stars as a result of rapid axial rotation. W. W. Morgan finds strong lines of ionized manganese in thirteen stars of class B5-A0 in addition to α Andromedae. E. M. Lindsay has made a spectrophotometric study of three of the hydrogen lines throughout the sequence O-M, determining total absorptions and a lower limit for the number of atoms in the 2-quantum state.

James Stokley described the plans for The Benjamin Franklin Memorial and Franklin Institute Museum. The Astronomical Section, which is to contain a planetarium, a 10-inch refractor and a 20-inch reflector, should be completed by the end of 1931.

The newspapers carried exceptionally good accounts of the meetings due to the coöperation of the authors with *Science Service* and to the seriousness with which J. Q. Stewart took his work as press secretary.

After the session Thursday afternoon many members accepted the invitation to be shown the University buildings under the guidance of amiable students. On Friday afternoon everyone went to the Observatory, looked through the tube of the catalogue camera, approved the measuring machines and Schilt photometer, climbed the tower of the Loomis Telescope, and enjoyed tea and other good things with Mr. and Mrs. Schlesinger.

At the end of Mr. Arnold's travelogue on Tin Can Island, Thursday evening, it was discovered that Mr. J. Q. Stewart had with him a Mt. Wilson film of sunset on the moon, and Mr. Philip Fox one of the Planetarium projector, which they were persuaded to show.

In my copy of the proposed announcement of the New Haven meeting, which I sent Professor Schlesinger I wrote "The customary dinner with speeches will be enjoyed on Friday evening." He crossed out the word "enjoyed" and wrote "endured." I suspect that he had a premonition that he would be one of the speakers, but I still think my choice of word was the better. The speeches were of that spontaneous, ebullient character in which words play an important part, but I do remember that President Brown seemed thoroughly convinced that astrology should not be taken seriously; that Ex-President Schlesinger felt no regret that the meetings had become less formal; that Ex-Secretary Stebbins had listened to and edited a thousand papers; and that Ex-President A. A. V. S. O. Pickering thought that the audience would pay better attention to the papers if the authors knew what to do with their hands. Full opportunity was offered for others to speak but there were no volunteers. An impromptu party in which Messrs. Bok and Vyssotsky made a charming couple in the Virginia Reel closed the evening.

JUPITER

As bright as new moon's crescent, Jupiter
Rose steadily above the bank of trees,
Willow and cottonwood, that fringed the stream,
And looked and saw his image wavering
Among the ripples that the paddle made,
And Saturn reddened on the heavenly scene
As Venus paled within the verge of day.

Now on the river there were they and I;
But in my thinking, their companionship
Linked me divinely with the ancient Greeks
Who must have passioned, seeing these, as I.
And I for them recalled the memory
Of one whose love before he died to me
Had wrought the unintelligible world to song.
It was an hour of wonder that we had,
The ancients and their gods and he and I,
Companioned there upon the river Linn.

—GRACE HUNTER.

820½ Main Street, Cedar Falls, Iowa.

THE LIGHT CURVES OF LONG-PERIOD VARIABLE STARS

By PAUL W. MERRILL.

(Fourth Paper)*

Our most precious data concerning long-period variables are the records of their variations in brightness during past years. A partial orderliness prevails in the behavior of these variables, but they display no clock-like regularity and are not as yet subject to precise calculation. To find out *why* they vary, we must first know exactly *how* they vary, and this we cannot learn except by watching them for a long time. Observations over a short term of years will not give us mastery of the difficult problems involved. Hence the great value of a knowledge of the past behavior of these objects.

Raised to a high plane of accuracy and reliability by Argelander[1] in the middle of the last century, the systematic observation of variations of brightness is now more advanced than any other branch of the study of long-period variables. This is largely because this kind of work may be satisfactorily carried out with small telescopes and inexpensive equipment, and is thus well adapted to amateur astronomers, many of whom have made splendid use of their opportunities. Probably more persons have participated in the determination of the changes of brightness of long-period variables than in any other type of astronomical investigation. The Variable Star Section of the British Astronomical Association, the American Association of Variable Star Observers, and similar organizations in other countries have done and are doing work of great importance in keeping track of numerous variables and in arranging for the systematic compilation of the observations. Any amateur astronomer seeking a useful job would do well to consider variable star observing, and if interested should write to the American Association of Variable Star Observers, care of Harvard College Observatory, Cambridge, Massachusetts, for advice and assistance.

The history of the changing light intensity of a variable star is ordinarily exhibited by a graph known as a light curve. A time scale is laid off from left to right along a horizontal line, every point of which corresponds to a particular instant. The observed brightness at any time is represented by a point whose vertical distance above the horizontal line is a measure of the brightness[2] on some pre-determined scale, usually that of stellar magnitudes.[3] A non-variable star is represented by a

*For preceding papers, see February, May, and October (1929) issues.

[1] Director of the Observatory at Bonn, Germany, 1837-1875.

[2] Strictly speaking, brightness refers to the visual sensation, but no great confusion seems to arise from the common practice of using it for either the visual sensation or the physical light intensity.

[3] In mathematical language, rectangular Cartesian coördinates are employed in which time is taken as the abscissa, brightness or magnitude as the ordinate.

horizontal line; one increasing in brightness by a line sloping up toward the right; one decreasing in brightness by a line sloping down toward the right. The steepness of the line indicates the rate at which the brightness is changing. A vertical segment would mean an instantaneous change.

The universal method of reckoning the brightness of stars is by the stellar *magnitude* scale which has an ancient and honorable history. Hipparchus and other ancient astronomers divided the naked-eye stars into six classes according to their brightness, calling the classes the first, second, . . . sixth magnitudes. This system has continued in use until the present time but has been extended both in range and accuracy. For centuries there existed no logical definition of the scale, and various observers differed considerably in the numbers assigned to the same stars. This was particularly true of magnitude estimates of telescopic stars between the years 1610 and 1885. About 1830, measurements by Sir John Herschel showed that the average first magnitude star is about one hundred times as bright as one of the sixth magnitude, and in 1850 Pogson suggested that this ratio be made, by definition, the basis of the magnitude scale. This means that the ratio between two successive magnitudes raised to the fifth power, to pass from magnitude six to magnitude one, shall equal 100, or in other words that the ratio of brightness between two successive magnitudes shall be the fifth root of 100, or slightly more than 2.512. For an approximation easy to remember, we may say that each magnitude is two and one-half times as bright as the next fainter one. Pogson's proposal finally found general acceptance and the zero point of the scale was fixed in the first place by adjusting the first six magnitudes to conform as nearly as possible to those assigned by Argelander in his great star catalogue, the Bonn Durchmusterung. The zero point is now defined in a more precise way, the rather involved details of which are not important for the practical use of the system.

In the magnitude scale each step represents not a certain quantity or unit of light, but a certain *ratio*.[4] This gives a scale whose properties are quite different from those of the scales with which we are most familiar such as those of length or weight, but which is much more convenient for many purposes. It is well adapted, for example, to deal with the enormous range in the apparent brightness of observable stars. The brightest stars are many hundred million times as bright as the faintest which can be photographed with large telescopes, but it would be awkward, and wholly unnecessary from the standpoint of attainable accuracy, to use nine figures to express the brightness of any star. This is avoided by the magnitude scale, which is so compressed that a difference of 20 corresponds to a brightness ratio of 100,000,000 to 1. Moreover, the magnitude scale automatically selects an appropriate unit for use with a star of any brightness. The smallest amount of light which is

[4] The mathematician would call such a scale logarithmic or exponential.

physically important is not a fixed unit of light intensity, but something that depends on the brightness of the star under consideration; it is in fact a certain proportion of the star's light, however great or small that may be. For example, if the light of a very faint star should increase twenty-five per cent the change would be observable and important but the same actual amount of light added to that of a very bright star would be utterly insignificant and undetectable. The convenience of the magnitude scale for visual observation is founded upon a psychological relationship formulated in Fechner's famous law, as follows: The least observable increase in a stimulus is proportional to the stimulus itself.[5]

If I_s is the light intensity of a star of magnitude s, and I_t that of a star of magnitude t, then the relative intensity of the two stars, I_s/I_t, is given by the equation

$$I_s/I_t = 2.512^{(t-s)} \quad \text{or} \quad \log_{10} I_s/I_t = 0.4\,(t-s).$$

From this equation we may compute the apparent relative brightness of two stars, whose magnitudes differ by any given amount. Table I gives a good idea of the relationship between the two quantities.

TABLE I.

RELATIVE LIGHT INTENSITY CORRESPONDING TO A GIVEN DIFFERENCE IN MAGNITUDE.

Difference in Magnitude	Relative Intensity	Difference in Magnitude	Relative Intensity
0.00	1.000	2.0	6.31
0.01	1.009	2.5	10.00
0.1	1.096	3.0	15.85
0.2	1.202	3.5	25.12
0.3	1.32	4.0	39.81
0.4	1.45	5.0	100.00
0.5	1.58	6.0	251.2
0.6	1.74	7.0	631.0
0.7	1.91	8.0	1,585.
0.8	2.09	9.0	3,981.
0.9	2.29	10.0	10,000.
1.0	2.51	15.0	1,000,000.
1.5	3.98	20.0	100,000,000.

If the light range of a variable does not exceed one or two magnitudes the light curve looks about the same whether plotted in actual intensity or in stellar magnitudes, but if the range is five or more magnitudes, as is frequently the case in long-period variables, the appearance of the two curves is very different. Figure 1 shows the mean light curve of χ Cygni (1902-1905) on both systems. Table II gives the data from which Figure 1 was constructed. The magnitudes of the mean light curve were taken from *Harvard Annals*, **57**, 195, 1907. It is obvious that the *magnitude* curve is the more convenient of the two. The *intensity* curve is awkward to plot because of its large numerical range:

[5] Alternative statements of Fechner's law are: Sensation is proportional to the logarithm of the stimulus; or, In order that the intensity of a sensation may increase in arithmetical progression, the stimulus must increase in geometrical progression.

if the scale be so chosen that the differences near minimum are clearly shown, the maximum rises to an undue height; while if the scale is made smaller to give a reasonable height to maximum, a large portion of the curve near minimum is so compressed as to appear flat. The *magnitude* scale is not subject to this difficulty and for this as well as for other reasons is regularly used for practical purposes; in fact curves of the other type are seldom seen.

TABLE II.

MEAN LIGHT CURVE OF χ CYGNI, 1902-1905.

Phase	Magnitude	Magnitude Difference	Relative Intensity
0 days	4.69	8.37	2229.
17	4.83	8.23	1959.
34	5.43	7.63	1127.
51	6.21	6.85	549.5
68	7.05	6.01	253.5
84	7.87	5.19	119.1
101	8.64	4.42	58.61
118	9.37	3.69	29.92
135	10.04	3.02	16.14
152	10.64	2.42	9.290
169	11.15	1.91	5.808
186	11.69	1.37	3.532
203	12.19	0.87	2.228
220	12.63	0.43	1.486
237	12.98	0.08	1.076
254	13.06	0.00	1.000
270	12.61	0.45	1.514
287	11.80	1.26	3.192
304	10.88	2.18	7.447
321	10.09	2.97	15.42
338	9.36	3.70	30.20
355	8.53	4.53	64.86
372	7.08	5.98	246.6
389	4.97	8.09	1722.

The brightness of a variable star is nearly always determined by referring it to nearby stars of known magnitudes. For long-period variables this has usually been done by direct visual estimates. Felix de Roy has outlined most concisely the methods thus employed to give a numerical result.[6] "As is well known, two methods of determining the brightness of variables under observation are in general use: (1) the Fractional Method, by which the brightness is estimated as a fraction of the light interval between a pair of comparison stars, the fraction being either a simple one (General Method), or a decimal one (Pickering's Decimal Method); and (2) Pogson's Step-Method, by which the variable is estimated as so many "steps" brighter than one comparison star, and so many "steps" fainter than another, the step being assumed to be 1/10 of a magnitude.

"It should be understood that, strictly speaking, Pogson's method is, in many cases, a fractional method, or a combination of the fractional method and Argelander's original "step" method. An observer compar-

[6] *Memoirs British Astronomical Association*, **28**, p. XIX, 1929.

ing a variable with two comparison stars, *knowing* that $a = 9^M.0$ and $b = 9^M.5$, and estimating it $a - 2$, $b + 3 = 9^M.2$, is performing a fractional operation in which the denominator of the fraction (in this case 5) is always made equal to the number of tenths of magnitude between the two comparison stars. When, as frequently occurs, the observer uses one comparison star only, and makes some comparison such as $a + 3 = 8^M.7$, he is falling back upon the true "step" method, though it may be supposed that, from practice and knowledge of adjacent intervals, the interval "3", in this case, will not differ much from $0^M.3$."

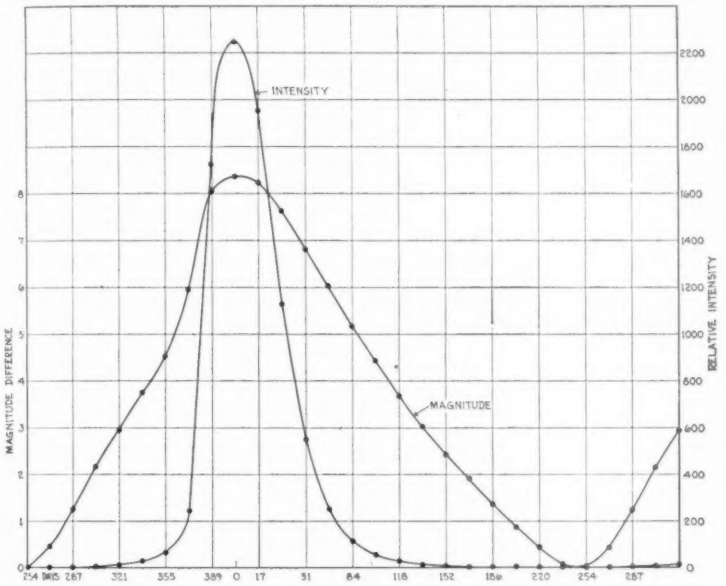

FIGURE 1.

MEAN LIGHT CURVE OF χ CYGNI, 1902-1905,
in Magnitudes, and in Amount of Light (intensity or candle-power)
relative to that at Minimum.

Many details concerning star charts and other matters connected with actual observing are explained in an excellent book by Miss Furness, "An Introduction to the Study of Variable Stars,"[7] and in Hagen's German treatise "Die Veränderliche Sterne." In the present article we cannot deal further with the methods of determining magnitudes of variables but must hasten to a consideration of the results.

The first step in a present day study of long-period variables should be to examine with care the light curves of numerous stars. The curves of individual stars should be studied separately, then intercompared.

[7] Houghton, Mifflin Co., 1915.

They will be found to differ markedly in period, light range, shape, and degree of regularity. Mean curves, averaged over a number of cycles, such as that in Figure 1 are very useful but the original curves showing the actual day-to-day behavior of the stars are more fundamental and should receive particular attention. A few examples are given in Figures 2, 3, and 4.

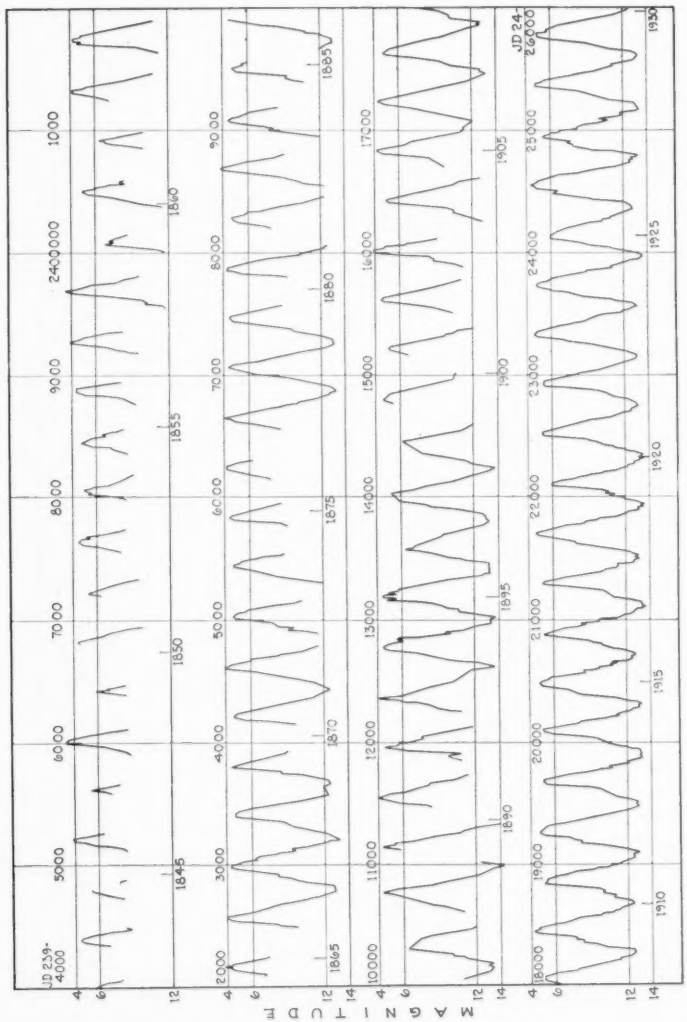

FIGURE 2.
LIGHT CURVE OF χ CYGNI, 1842-1930.

For excellent curves of a number of well-known variables see *Memoirs of the British Astronomical Association* Appendix to volumes XV and XVIII (1900-1909) and Appendix to volumes XXII and XXV (1910-1919). These curves exhibit the splendid work of the Variable Star Section of the British Astronomical Association. Many data in tabular form are printed in *Harvard Annals*, volumes 37, 57, 79. Mean light curves are found in *Harvard Annals*, **37**, 144, 1900, and **57**, 210, 1907.

χ Cygni,[8] one of the best known long-period variables, was discovered in 1686 by G. Kirch, who with other members of his family kept track of its brightness until 1738. During this interval, observations were made also by Maraldi, Cassini, and Halley. The data are too meager, however, for satisfactory determination of the epochs of maxima. The following astronomers observed the star during the years indicated: Le Gentil 1747-1758; Pigott 1783-1785; Olbers 1815-1826; Schwerdt 1826-; Argelander 1841-; J. Schmidt 1845-1885. Since 1885 the observations have been numerous.

Figure 2, from data compiled by Mr. Leon Campbell of the Harvard College Observatory, and made available through the courtesy of Director Harlow Shapley, shows the light curve from 1842 to 1930 as completely as it can be determined from all known observations. The observed maxima prior to 1842 are very scattering, as are also the observed minima before 1905. A detailed account of the magnitude observations from the time of discovery (1686) to 1901 has been published by Hans Rosenberg.[9] Inspection of Figure 2 shows that the magnitude at maximum varies from 3.5 (1847) to 7.0 (1859). Rosenberg gives 3.3 and 7.3, respectively, for these dates. The minimum magnitudes seem more consistent; nearly all that are well determined lie between 12.5 and 14.0, while the extremes are perhaps 12.2 and 14.5. The total range from the faintest minimum to the brightest maximum exceeds 10 magnitudes or a brightness ratio of 10,000 to 1. A being on a hypothetical planet revolving about χ Cygni must lead a weird, irregular existence if upon the effects of the variation of the star are superposed season (orbital) changes in a different period.

Mr. Campbell has supplied also the typical curves shown in Figures 3 and 4. The points connected by straight lines to form the light curves represent ten day means based on all available observations. I am much indebted to Mr. Campbell for the pains he has taken to make these curves complete and accurate. Data concerning the stars are given in Table III.

Inspection of the figures will suggest many features which merit detailed study. One broad field of investigation is that of systematic peculiarities of individual variables. An excellent example is the hump

[8] 194632; average maximum magnitude, 5.1; average minimum magnitude 13.3; period 406.6 days; spectrum at maximum M6pe.

[9] Der Veränderliche χ Cygni, Inaugural Dissertation Kaiser Wilhelm's Universität Strassburg, Halle a. d. S. 1906.

or shoulder on the rising branch of the curve of T Cassiopeiae. Another is the presence of abrupt irregularities in the curve of S Cephei. Can these be merely errors of observation caused by the difficulty of estimating a very red star? Mr. Campbell, whose vast experience with photometric data entitles his opinion to high weight, thinks not. It is surely

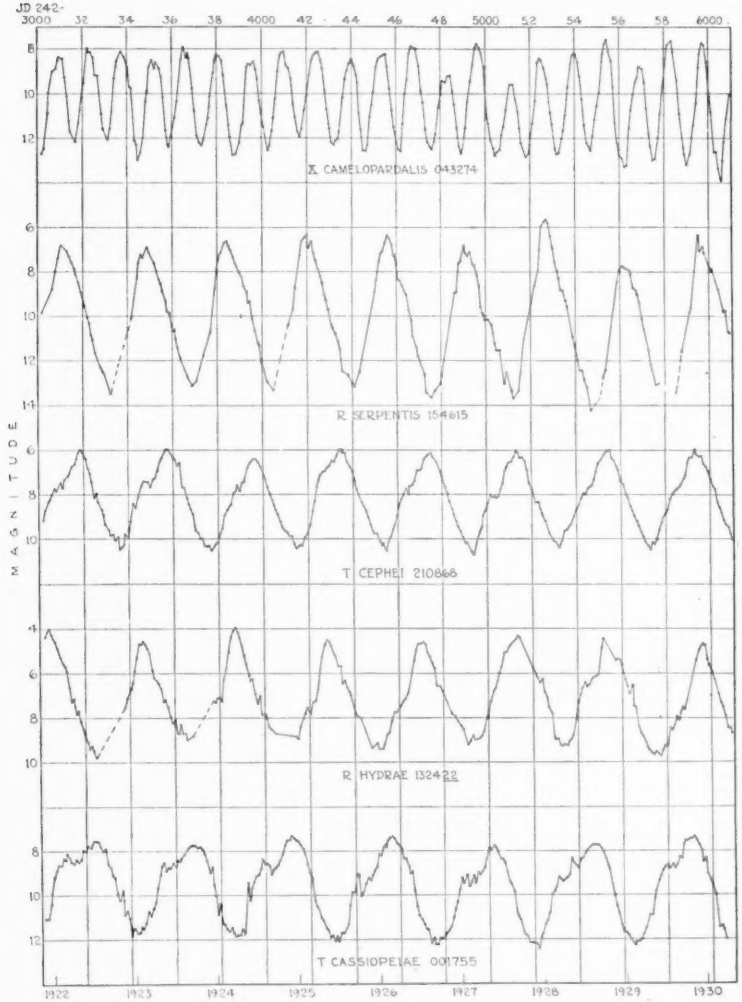

FIGURE 3.
LIGHT CURVES OF LONG-PERIOD VARIABLES HAVING SPECTRA OF CLASS Me (1922-1930).

TABLE III.

DATA CONCERNING VARIABLES WHOSE LIGHT CURVES ARE SHOWN IN FIGURES 3 AND 4.

Variable	Designation	Magnitude Max.	Magnitude Min.	Period Days	Spectrum at Max.
X Camelopardalis	043274	8.2	12.8	142.3	M3e
R Serpentis	154615	6.9	13.0	357.2	M7e
T Cephei	210868	6.1	10.1	387	M7e
R Hydrae	1324*22*	4.2	9.5	405	M7e
T Cassiopeiae	001755	8.2	11.9	443	M8e
S Ursae Majoris	123961	7.9	11.5	225.3	Se
S Cassiopeiae	011272	8.3	14.5	612.5	Se
RV Centauri	133155	7.0	9.5	460	N3
S Cephei	213678	8.1	11.3	485.8	N8e

difficult to believe that the difference in smoothness of the curves of S Ursae Majoris and S Cephei can be attributed wholly to errors of ob-

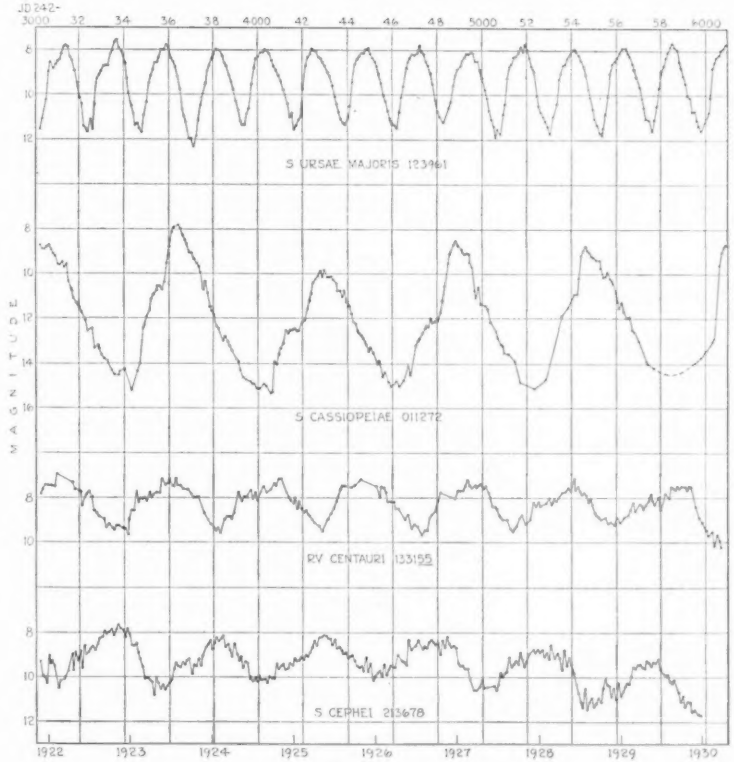

FIGURE 4.

LIGHT CURVES OF LONG-PERIOD VARIABLES HAVING SPECTRA OF CLASSES Se AND N (1922-1930).

servation. The curve of RV Centauri also is rather jagged. Is this a general characteristic of class N stars as compared with those of classes M and S?

The opportunities for logical discussion of many questions of this general type are increasing year by year with the accumulation of reliable data. Such investigations will doubtless eventually find their high-

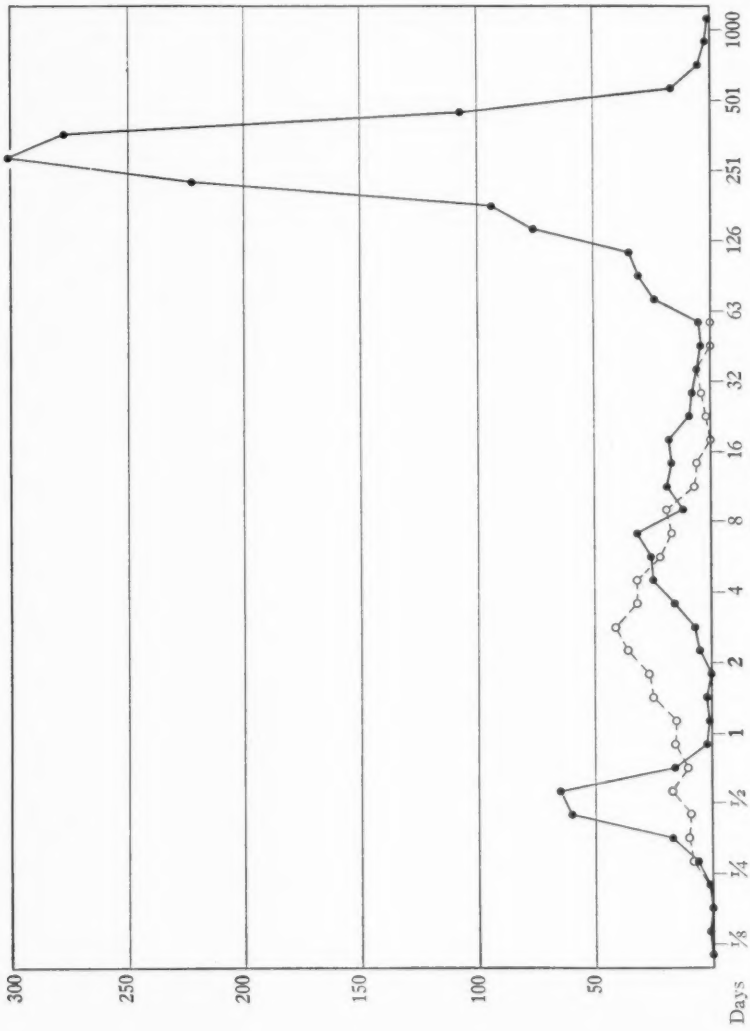

FIGURE 5.
FREQUENCY CURVES OF THE PERIODS OF VARIABLE STARS.
(Open circles represent Algol and β Lyrae type variables; solid circles all other variables.)

est value in correlation with detailed spectroscopic studies.

Extensive statistical investigations of light curves have been published, many of which are interesting and valuable. Space is lacking for a complete account of them, but a few results may be briefly mentioned.

Our knowledge of the periods of more than 2000 variables makes possible certain conclusions of which the most outstanding is that all periods do not appear with equal frequency but that periods near half a day, seven days, and 300 days are preferred, while intervals from one to two days and from thirty to sixty days are avoided. This is clearly exhibited by Figure 5, the data for which were taken from Prager's "Catalogue of Variable Stars for 1930".[10] The main curve (solid circles and line) represents 1662 variables not including 292 Algol variables and 76 β Lyrae stars which were combined to form the dotted curve (connecting open circles). The reason for treating these types by themselves is that their periods are merely those of the orbital revolution of companion stars, while the periods of the remaining variables are probably dependent on intrinsic properties of individual globes, such as mass, density, temperature, and chemical composition.

The relationship between period and spectrum is interesting and important. Long-period variables of classes O, B, A, and F are unknown; a very few are of classes G, K, and R; while the vast majority are in classes M, S, and N. In passing along the spectral sequence from hotter to cooler stars the likelihood of long-period variability increases to the very end of the sequence, and the period also tends to increase. A well-known rule which states a general truth is, the redder the star the longer the period.

The mean and median periods of the main spectral types are shown in Table IV, the data for which were extracted from *Harvard College Observatory Bulletin*, 862, by Campbell and Miss Cannon.

TABLE IV.

SPECTRAL TYPE AND PERIOD.

Spectral Type	Mean Per. Days	Median Per. Days	No.
All	284	280	1077
M*	216	165	78
Me	298	281	390
Se	367	349	25
N†	379	381	26

*Non-emission.
†Classified as non-emission but several are now known to have bright hydrogen lines.

M-type stars with emission lines have longer periods than those without emission lines, while Se stars have still longer periods. In these cases there is probably an inverse correlation with density, the stars with

[10] This diagram is similar to that in "Astronomy" by Russell, Dugan, and Stewart, p. 759, but is based on a larger number of variables, and includes a separate curve for Algol and β Lyrae stars.

the longer periods having the lower average densities. The reason for the relatively long periods of the N-type stars is not known.

The Me stars exhibit a definite increase of period with advance in spectral subdivision. The data in Table V are also from *Harvard Bulletin*, 862.

TABLE V.

SUBDIVISIONS OF CLASS Me AND PERIOD.

Spec. Class	Mean Per. Days	No.	Period Days	Mean Spec.	No.
M0e	137	1	100-149	M2.4e	20
M1e	158	5	150-199	3.0e	25
M2e	219	32	200-249	3.3e	61
M3e	242	86	250-299	3.8e	79
M4e	292	77	300-349	4.9e	91
M5e	308	62	350-399	5.8e	50
M6e	343	69	400-449	6.3e	31
M7e	392	47	450-499	5.9e	9
M8e	446	2	500-549	6.4e	5

The magnitude range between maximum and minimum light may be studied in much the same way as the period. Here again the data in *Harvard College Observatory Bulletin*, 862, are useful. The dependence

TABLE VI.

SPECTRAL TYPE AND MAGNITUDE RANGE.

Spectral Type	Range Mag.	No.
All	3.8	457
M*	1.6	76
Me	4.5	318
Se	4.8	22
N†	2.1	24

*Non-emission.
†Classified as non-emission but several are now known to have bright hydrogen lines.

of range on spectral type is marked: the average range of variables of types Me and Se is nearly five magnitudes, while that of N-types is about two magnitudes, and of non-emission M-types still less. (See Table VI.) The proportion of stars having emission lines increases with the range, as one might expect for physical reasons. Within class Me the range increases with spectral subdivision as shown by Table VII.

TABLE VII.

SUBDIVISION OF CLASS Me AND MAGNITUDE RANGE.

Spectral Class	Mean Range Mag.	No.
M0e-1e	2.7	5
M2e	4.4	26
M3e	4.5	65
M4e	4.5	64
M5e	4.7	53
M6e	4.3	61
M7e-8e	4.9	37

Both period (Table V) and range increase with spectral subdivision; range will therefore increase with the period, but above 300 days the progression is not marked. (See Table VIII.)

TABLE VIII.

PERIOD AND MAGNITUDE RANGE FOR VARIABLES OF CLASS Me.

Period	Mean Range Mag.	No.
100-149	2.9	15
150-199	3.4	32
200-249	4.5	49
250-299	4.6	69
300-349	4.8	75
350-399	4.9	40
400-449	5.0	25
450-499	4.8	8
500-549	5.1	4
550-599	5.0	1

The *shapes* of the light curves of individual stars offer a large and important field for study. For statistical purposes, irregularities of the original curves are smoothed out by forming mean curves from a number of cycles. These mean curves exhibit characteristic peculiarities which have been classified and analysed in various ways.

H. H. Turner[11] many years ago made a mathematical investigation of the light curves of several long-period variables. Applying the method of harmonic analysis, he represented the curves by Fourier's series of six sine and cosine terms. He suggested, in addition, that the time between minimum and maximum as compared to the whole period may be taken as characteristic of a variable. His formula is

$$\alpha = [2(M - m) - P]/P$$

where α is the characteristic parameter, M the time of maximum light, m that of the preceding minimum, P the period. α is negative when the rising branch is steeper than the descending, zero when the curve is symmetrical, and positive when the descending branch is the steeper. C. Luplau Janssen[12] called attention to the fact that variables with negative values of α (steep ascent) tend to have larger magnitude ranges than the others. Rev. T. E. R. Phillips[13] applied Turner's method to a large number of stars, and classified them according to the phases of the second and third harmonics. This procedure brought out two distinct groups of light curves which Phillips described as follows: ". . . in Group I we notice that the intervals from maximum to minimum and from minimum to maximum are not very unequal, and that there is a marked tendency for the curve to show a pause on the rise. In Group II there is a sharp rise to maximum followed by a long period of decline, so that the interval from minimum to maximum is relatively short, and the general shape of the curve is not unlike the transverse section of an

[11] *Monthly Notices, R.A.S.*, **64**, 543, 1904; **67**, 332, 1907; **68**, 482, 1908.
[12] *Astrophysical Journal*, **38**, 200, 1913.
[13] *Journal of the British Astronomical Association*, **27**, 2, 1917.

incoming wave near the shore before it breaks and falls over." As typical stars he gave:

Group I, T Cephei, R Aurigae, S Ursae Majoris, R Boötis
Group II, S Coronae Borealis, R Ursae Majoris, R Aquilae.

He remarked that stars of Group II have greater magnitude ranges than those of Group I. This is essentially the same fact previously noted by Janssen.

The mathematical analysis by trigonometric series was further discussed by Turner,[14] and Hagen.[15]

A few years ago Campbell, following up earlier work at the Harvard College Observatory, divided the light curves into seven types,[16] depending largely on the relative widths of maxima and minima. (See Figure 6.) Campbell says, "It will be seen that as the types progress the maxima become narrower with a steeper drop to minima, while the minima become more flattened and the increase to maxima more rapid. Group III represents very closely a sine curve, in which maxima and minima

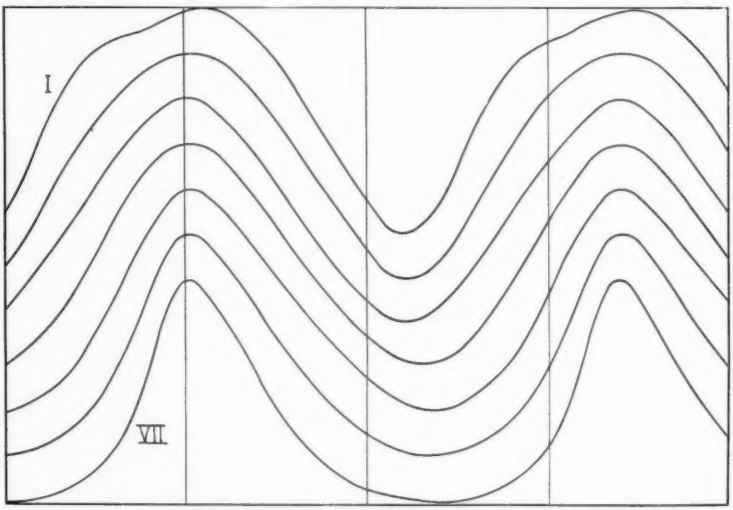

FIGURE 6.
CAMPBELL'S SEVEN TYPES OF LIGHT CURVES.

are equal. These seven types appear to form a continuous series and perhaps should not be called types, except for convenience of description." The first type is represented by T Cassiopeiae and U Canis Minoris, the last by S Tauri and R Aquarii.

Ludendorff[17] has classified the curves of long-period variables ac-

[14] *Monthly Notices, R.A.S.*, **78**, 92, 1917; **79**, 371, 1919.
[15] *Astronomische Nachrichten*, **209**, 257, 1919.
[16] *Harvard Reprint*, No. 21.
[17] *Handbuch der Astrophysik*, p. 99.

cording to their shapes in three main classes as follows:

α Rise of the curve notably steeper than the descent; minimum broader than maximum.
β Curve essentially symmetrical; rise little if any steeper than the descent.
γ Curve has a hump or a shoulder in the rising branch, or has a double maximum.

Subdivisions of the main classes are thus described:

α_1 Curve has a constant or nearly constant phase of considerable duration ($\frac{1}{3}$ to $\frac{1}{2}$ the period) at minimum; rise usually very steep. Example, Y Velorum 1922-1924.
α_2 Minimum very broad but has no continued constant phase; rise usually very steep.
α_3 Minimum not so broad as in α_2, but the rise nevertheless quite steep. Example, o Ceti 1913-1914.
α_4 Like α_3 but the rise less steep. Example, R Draconis 1915-1916.
β_1 Maximum sharper than minimum. Example, R Boötis 1918-1919.
β_2 Maximum of the same shape as minimum.
β_3 Maximum flatter than minimum. Example, X Camelopardalis 1916-1917.
β_4 Maximum is very broad and has a long constant phase.
γ_1 Hump or shoulder on the rising branch. Example, R Aurigae 1916-1917.
γ_2 Double maximum. Example, R Normae mean curve.

Ludendorff gave the classification of a large number of variables according to this system and included a statistical discussion of the results.

A vast and profitable field for research is offered by the lack of uniformity in various cycles of individual stars. Two types of non-uniformity may be recognized: first the irregularities in period and shape from cycle to cycle, second a secular or systematic tendency toward modification of the period or the nature of the curve. Neither type has been sufficiently investigated.

Irregularities in the intervals between maxima soon become apparent to all who observe these stars with any degree of persistence; and they are obvious from the plotted curves. Each December Mr. Campbell predicts for the following year the dates of maxima and minima of several hundred long-period variables. The average differences between predicted and observed dates for 1928 were for maxima ± 11.1 days, for minima ± 13.1. For 35 per cent of the stars the predicted dates were within 5 days of the observed maxima, and for 9 per cent they differed more than 25 days. Certain stars are known to be habitually more regular than others.

Eddington and Plakidis[18] made a mathematical investigation of the nature of the irregularities in the periods of o Ceti and χ Cygni. They found the average deviation of an individual period from the mean to be 1.35 per cent for o Ceti, 1.39 per cent for χ Cygni. They listed the following possible types of irregularity.

(1) The individual period may differ from the mean by a purely accidental fluctuation independent of previous fluctuations.

(2) The individual period may be correlated either positively or negatively to those preceding it.

[18] *Monthly Notices, R.A.S.*, **90**, 65, 1929.

(3) The irregularity may be a fluctuation of phase rather than of period. The effect of a perfectly regular cause may be delayed or accelerated by casual circumstances.

(4) The casual circumstances referred to in (3) may be long enduring so as to affect a succession of maxima.

(5) The irregularity may be due to periodic causes.

They decided that the irregularities of o Ceti and χ Cygni are consistent with (1). Miss Payne and Mr. Campbell[19] made a similar study of several other variables but did not arrive at conclusions of general applicability.

On a previous page it was remarked that the magnitudes of χ Cygni at minimum light seem more consistent than those at maximum light. A short investigation by the writer appears to indicate that this is true in general for variables whose spectra have titanium oxide bands but doubtful for others. The method was to compare the average deviation (from the mean value) of the magnitudes at individual maxima with that of the minimum magnitudes. For seven Me stars (including χ Cygni) it was found that in the mean the average deviation at maximum is about 1.4 times that at minimum. A systematic investigation of a larger number of variables is desirable.

For investigations of systematic changes in the light curves, data at present available are in most cases inadequate and we must await the future accumulation of more accurate and extensive observations. This is especially true of the amplitudes and shapes of the curve. Circumstances are somewhat more favorable for studies of the period, and several writers have given close consideration to the question of change of period. It is of course of much importance in the interpretation of the nature and cause of long-period variability.

In most stars the systematic or cumulative changes in period appear to be small compared to the irregularities of individual maxima, but several exceptions are known, of which the most striking are R Hydrae and R Aquilae. The period of R Hydrae[20] decreased from about 500 days at the end of the eighteenth century to about 400 days at the beginning of the twentieth. From 1784 to 1848 the average decrease was at the rate of 0.11 day per cycle; from 1848 to 1914, 0.67 day per cycle. The period seems to have reached a minimum value in 1918 and to have increased since that year.[21] The period of R Aquilae[22] decreased from 349 days in 1853 to 310 days in 1925. The average rate of decrease was 0.47 day per cycle.

[19] *Harvard College Observatory Bulletin*, 875.
[20] Ludendorff, *Astronomische Nachrichten*, **203**, 117. 1916.
[21] R. Müller, *Astronomische Nachrichten*, **237**, 81, 1930.
[22] Ibid, **223**, 185, 1924.

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AMERICAN ASTRONOMICAL SOCIETY

REPORTS OF OBSERVATORIES
1929-1930

(Continued from page 89.)

DUDLEY OBSERVATORY
ALBANY, NEW YORK

Albany Catalogue. The Albany Catalogue containing the positions of 20,775 stars for the epoch 1910.0 has gone to press.

General Catalogue. Systematic corrections and weights have been determined for all the catalogues received to date which will be used in deriving the standard positions and motions of the *General Catalogue.* The entry of the observed positions on the catalogue cards is complete to date and the comparison of these positions with provisional ephemerides is complete except for about half the stars of the *Preliminary General Catalogue.* The application of the systematic corrections to reduce the observations to homogeneity is complete for the northern miscellaneous stars, and the normal equations, from which the definitive positions and motions will be derived by least squares solutions, are being formed. Considerable work has been done upon the fundamental catalogues in collecting data to be used for correcting the system of the *Preliminary General Catalogue.* The revisions of ephemerides for circumpolar stars and for stars whose adopted proper motions appear to be erroneous and studies of the observations of double stars, which contain many perplexing anomalies, are about half completed.

Relationships between Geophysical and Astronomical Phenomena. Investigation of relationships between magnetic variations, earthquake frequency, atmospheric potential gradient, and Moon fluctuations has been made, and an explanation attempted which indicates a diurnal earth pulsation varying with the seasons and secularly.

Space Motions. During the year Wilson and Raymond published their discussion of the space motions of 4233 stars. The principal conclusion, in addition to those reported last year, was that the motions of these stars may be fairly well represented on the theory that the stellar system is rotating about a center in galactic longitude 329° at a rate represented by the rotational coefficients, $A = +.015$ and $B = -.016$ km/sec/parsec. The angular rate of rotation in the neighborhood of the Sun is ″.0065 per year and the period of rotation, therefore, about 200,000,000 years. The distance of the Sun from the center of the Galaxy is found to be 8800 parsecs.

Positions and Proper Motions. Wilson has determined preliminary proper motions of 298 Class B stars for use in studies of the motions

and distances of these stars by Dr. J. S. Plaskett and the positions of 96 occultation stars for Prof. E. W. Brown.

Stellar Wave-Lengths. Albrecht has published his determinations of wave-lengths and his identifications of lines in the spectrum of γ Geminorum and has completed a similar study for Procyon. He has also completed measures of radial velocity and wave-lengths based upon Yerkes 3-prism spectrograms of six other stars.

BENJAMIN BOSS, *Director.*

FLOWER OBSERVATORY

UNIVERSITY OF PENNSYLVANIA

UPPER DARBY, PENNSYLVANIA

The year 1929-30 was the first for a decade in which a fairly adequate staff was present. The previous year had been largely used in putting the instruments and buildings into condition for effective use. Despite this, the work on double stars was pushed by Mr. Barton and the writer, and variable star work begun by the latter. In September, 1929, Mr. A. H. Mason and Mr. W. P. Wamer joined the staff as assistants. In the meantime, Mr. F. G. Fender and Professor Asaph Hall, Jr., had acted as volunteer observers. The sad death of the latter, so soon after arriving here, was a great misfortune. Through the year, all the staff took part in the double-star program, using the 18-inch refractor. Work on certain new variable star regions was also done by the writer. The other instruments were used for instruction mostly.

The headquarters of the American Meteor Society was moved here from the McCormick Observatory in 1928. In the two past years many new members have joined and the volume of work has greatly increased. "Meteor Notes" are regularly supplied to POPULAR ASTRONOMY. A new series, "Reprints of the Flower Observatory," is being issued, four having been mailed to date.

Mr. Barton has continued his search for new double stars in certain Astrographic Zones with success. Mr. Fender has also done some of the same work. Besides what has been mentioned, the rest of the staff took part in researches connected with the vast amount of data on meteors, now at hand here. Mr. Barton and the writer both taught several classes in astronomy. The Observatory is open to visitors every Thursday evening during the regular session.

CHAS. P. OLIVIER, *Director.*

GOODSELL OBSERVATORY

CARLETON COLLEGE

NORTHFIELD, MINNESOTA

As usual the greater part of the time of the staff was given to instruction of college classes in astronomy. The enrollment in five classes totaled 103.

Daily time signals were furnished to railways and broadcast over the college station, KFMX; the observatory was open to the public one night in each month; about 150 bound volumes were added to the library.

The instrument maker completed a number of instruments and models for the astronomical laboratory and practically finished the work of remounting the 8-inch refractor.

The photo-electric photometer was finally so far advanced that it could be utilized for observations.

E. A. FATH, *Director.*

KODAK RESEARCH LABORATORIES

ROCHESTER, NEW YORK

Improvements in dye sensitizing have made it possible to make plates with greater sensitiveness through the green and also greater sensitiveness at Hα than those available before. Much work has been done on neocyanine derivatives with a view to getting increased sensitizing in the infra-red. Dyes were found which gave improved sensitiveness, but unfortunately they fog the plates too much to make their use possible.

S. E. Sheppard and his collaborators have published some of their results on optical sensitizing in connection with the theory of the latent image.

A. P. H. Trivelli has been studying the reversal region of the sensitiveness curve of photographic materials and has published a comparison of the properties of photographic plates in the reversal region with those obtained in the region of normal sensitiveness.

Trivelli has also studied the Herschel effect, especially in connection with the failure of the reciprocity law.

Trivelli and Silberstein published a paper on the quantum theory of exposure in relation to the effect produced by x-rays. While the experimental data show that a single grain rquires many quanta of visible light for its exposure, new results seem to show that a single quantum of x-ray frequency is sufficient to make a grain developable.

E. R. Bullock has been working on the growth of the latent image which occurs between exposure and development. He has demonstrated beyond doubt that such a growth occurs, but the extent of the growth is very erratic. His results imply that for photographic photometry it is necessary to hold exposures for a sufficient period to be sure that the latent image has come to a steady level. Thus, if two plates are exposed with an hour's interval between them and are then developed as soon as the second exposure is finished, the growth of the latent image on the first plate will introduce an error.

A. P. H. Trivelli has found that a number of the chemical substances which are known to diminish fog when introduced into the emulsion also act in the same way when they are used in developers. In a study of the chemistry of development, M. E. Dundon has shown that the

iodide liberated as the grains are developed converts some of the undeveloped silver bromide in the lower layers of the emulsion into silver iodide.

C. E. K. MEES, *Director.*

OBSERVATORIO ASTRONOMICO

UNIVERSIDAD NACIONAL

LA PLATA, ARGENTINA

From August to December, 1929, Dr. Fr. Lunkenheimer was in Germany and took part in the geophysical congress of Dresden. On May 31, 1930, he was sent into the regions of the Argentine province of Mendoza destroyed by the earthquake of May 30. A report of his investigations on this earthquake is in press. First Astronomer B. H. Dawson left La Plata in December, 1929, to spend a year's leave in North America. Astronomer Numa Tapia was absent, the whole year, on leave for study in Germany.

Astronomer Virginio Manganiello continued the revision of his Zone La Plata D —66° to —72° and prepared the manuscript. At the request of the International Latitude Commission the Observatory of La Plata commenced a new series of latitude observations in coöperation with the Adelaide Observatory. Both stations are situated on the same parallel and nearly 12 hours distant. Astronomer Manganiello, in charge of the latitude service, commenced observation with the Wanschaff zenith telescope in August, 1929. Astronomer Hugo A. Martinez, having finished the observations of the Eros fundamental stars, observed the latitude stars on the Gautier meridian circle.

Mr. B. H. Dawson and Mr. Martin Dartayet observed with the 43-cm refractor the southern comets, variables, and occultations by the moon. The corresponding computations have been made by Mr. Dartayet. Mr. Dawson computed the orbit of Comet 1929 *c*. Comet 1930 *d* (Schwassmann-Wachmann) and some planetoids have been observed photographically by Mr. Hartmann.

Much work has been done on remodeling our old 80-cm Gautier reflector, which never had been used because of its bad construction. The instrument is now transformed to a convenient Cassegrain with excellent Zeiss mirrors (1 : 20) and will serve, firstly, for spectroscopic and photometric work.

I have examined various color filters and, as a result, I recommended the Schott glass GG 11 for all visual observations, especially for the Eros parallax, photometric, and exact declination observations.

During the interval covered by this report there were published besides several articles in various periodicals: *Contribuciones Geofísicas*, vol. III, No. 1: F. Lunkenheimer, *Resultados sismométricos del año* 1926.

J. HARTMANN, *Director.*

LEANDER McCORMICK OBSERVATORY

UNIVERSITY OF VIRGINIA

UNIVERSITY, VIRGINIA

As in previous years, the determination of trigonometric parallaxes and proper motions of various classes of stars has constituted the major part of the work of the observatory staff. 1012 parallaxes had been completed on July 1. A number of visual doubles and of K stars with proper motion over 0″.1 per year have been added to the parallax program. Out of the 300 regions on the program for the determination of proper motions of faint stars, plates for the second epoch of 214 regions have been obtained and a majority of these measured. Two first epoch plates for 165 regions in the proper motion program for long-period variable stars have been secured. Stars with small amplitude variation and periods intermediate between those of classical Cepheids and long-period variables have been included in the program as well.

The photography of double stars with relative motion of the components has been continued. Those for which dynamical parallax determinations indicate a possible parallax of over 0″.04, have been included in the parallax program.

The Director has rediscussed his observational material on the flash spectrum in the light of recent developments of atomic physics.

Mr. van de Kamp investigated the evidence for general and selective absorption of light within the galaxy, using mainly photographic and photovisual magnitudes of faint B and A stars.

Mr. Vyssotsky obtained satisfactory photographs of the companion of Sirius and estimated its photovisual magnitude.

Mr. Asklöf has practically completed the definitive orbit of the comet 1917 I (Mellish) (second paper).

Mr. Reuyl obtained a number of plates for the purpose of investigating the sources of systematic errors in photographic measures of double stars.

On October 15, 1929, Miss Emma Williams joined the staff as a research fellow.

Mr. Reuyl left the observatory on August 1, 1930, and Mr. A. L. Bennett has been appointed a Vanderbilt fellow for 1930-31.

S. A. MITCHELL, *Director.*

LICK OBSERVATORY

UNIVERSITY OF CALIFORNIA

MOUNT HAMILTON, CALIFORNIA

Satisfactory progress has been made in the regular observing and research programs. Mr. Aitken's new general catalogue of double stars, Mr. Menzel's memoir on the flash spectrum, Mr. Bobrovnikoff's memoir on Halley's Comet, Mr. Trumpler's preliminary report on the open star clusters, and Mr. Neubauer's results for the radial velocities of

stars observed at the Chile Station, 1924-1929, were all completed, together with a number of shorter memoirs and articles, and the central eclipse of the sun of April 28, 1930, was observed successfully.

Mr. Wright, continuing his general program of photographic observations, secured filter photographs of Jupiter, Saturn, and Venus with the enlarging camera attached to the Crossley reflector for the study of the surface features of these planets in light of different wave-lengths. A number of photographs of the earth-lit moon were also taken in the direct focus at the request of Professor W. H. Pickering.

Mr. Wright has, in addition, been engaged upon a study of diurnal alterations of Martian clouds, based upon photographs taken in 1926 together with a number secured during that year by Mr. Frank E. Ross at the Mount Wilson Observatory and kindly loaned for the purpose. This study is not yet completed.

On 201 nights, out of the 240 on which observing was possible, the 36-inch refractor was in use for the whole night or for part of the night on the programs of spectrographic work in charge of Mr. J. H. Moore. On the program of the radial velocities of about 825 stars of spectral classes F to M and of photographic magnitude 8.5 to 8.6, 408 spectrograms were secured with the one-prism spectrograph which, with those taken in the preceding year, give one plate each for 526 stars and two each for 67 of them. A number of brighter stars with well-determined radial velocities were also observed with the same spectrograph to permit reduction of the results for the fainter stars to the system adopted for the brighter ones.

The second program relates to spectroscopic binary stars. During the year 248 spectrograms were taken with the three-prism Mills spectrograph including special series for Polaris, ϵ Librae, and α Cygni. Messrs. Moore, Neubauer, Meyer, Menzel, Paddock, Bobrovnikoff, and Krieger participated in the work of observation, and Mr. Paddock measured all of the one-prism spectrograms on the Hartmann spectrocomparator.

Mr. Trumpler continued his researches on the magnitudes, spectral types, and radial velocities of stars in the open clusters of the Milky Way. Twenty-one direct photographs with the two 4-inch Ross lenses, 114 spectrograms with the one-prism spectrograph on the 36-inch refractor, and 6 with the slitless quartz spectrograph on the Crossley reflector represent his work at the telescopes. Mr. Trumpler was in residence in Berkeley during the second semester. He neverthless found time to measure many of his plates, to make definite progress in the determination of photographic magnitudes, to compile a complete card catalogue of the open clusters, and to prepare a preliminary report on the distances, dimensions, and space distribution of the open star clusters, which was published as *Lick Observatory Bulletin,* No. 420.

This paper will rank as one of the most important contributions to astronomical literature made during the year, for it presents strong evidence for the existence of a light absorbing medium enveloping our

entire galactic system and concentrated toward its central plane. In low galactic latitudes this absorption amounts to about 0.67 magnitude (photographic) per 1000 parsecs distance. The absorption is selective, the effect on the visual magnitudes amounting to about half that on the photographic. Since the light from the extra-galactic nebulae passes through a comparatively thin stratum of this medium, conclusions based upon photometric studies of these objects will not be materially affected; but it is obvious that conclusions based on such studies of the distant objects in or near the galactic plane will require radical modifications.

Mr. Neubauer, in addition to assisting in the general programs of spectrographic work, secured 37 three-prism spectrograms for the study of the binary systems 27 Canis Majoris and L3 Puppis, and, in June, began work on a program for the determination of the radial velocities of the faint class B stars (to 9.0 photographic magnitude) between —10° and —30° declination. His chief task, however, was the measurement of the spectrograms secured by him at the Chile Station from January, 1924, to April, 1929; 947 spectrograms were measured during the year, giving the radial velocities of 351 stars fainter than 5.50 visual magnitude and south of —30° declination. Of 329 of these stars no previous measures for radial velocity had been made; 42 of them are probably spectroscopic binaries, for the observed radial velocities are variable. The results of these measures, together with a determination of the Sun's motion in space based upon the radial velocities of 393 class B stars, are ready for publication and will be printed early in the coming year.

Professor W. F. Meyer, of the Berkeley Astronomical Department, who was in residence during the second semester, assisted in the regular spectrographic programs, began a special study of β Canis Majoris, securing 25 additional spectrograms of the star, and made 5 micrometric observations of comets with the 12-inch refractor and 23 photographic measures, with the Crossley reflector, of the trans-Neptunian planet, Pluto. These, with the 5 plates of Pluto taken by Mr. Neubauer, greatly assisted the orbit computations carried out at the Students' Observatory.

Mr. Jeffers completed his observing program of the determination, with the Repsold meridian circle, of the positions of 1174 stars between +20° and +30° declination, and, with the part time assistance of Miss Phyllis Hayford, Miss Rebecca Jones, and especially of Miss Catherine Stillman and Mrs. M. W. Makemson, made considerable progress in the reduction of the final star places. The results, as they become available, are being sent to the Yale Observatory for use by Dr. Schlesinger in his photographic reobservation of the corresponding A. G. Zones.

Mr. Aitken continued his observing work with the 36-inch telescope, securing 681 sets of measures of close and difficult double stars, nearly all of them pairs of his own discovery. Much time was necessarily devoted to administrative duties, including the supervision of extensive repairs to the main observatory building. All available time, however,

was devoted to the completion of the new general catalogue of double stars to which reference has been made in earlier reports. The manuscript was ready for the printer at the close of the year and has now been sent to press by the Carnegie Institution of Washington. It contains the records of 17,186 double stars and will fill approximately 1500 double column quarto pages. It is a pleasure to acknowledge the efficient help given by a number of assistants: in the present year by Miss Catherine Stillman (for some months) and particularly by Mrs. Fredrica Chase Moore. Without her able assistance the catalogue could not have been completed before 1932 at the earliest.

Mr. Menzel devoted the greater part of his time to his study of the solar chromosphere, which was begun in 1926. With some assistance from Miss Catherine Stillman, Miss Phyllis Hayford, and Mr. Olin C. Wilson, he completed this study, which is based upon the plates of the flash spectrum secured by Dr. W. W. Campbell at the total eclipses of the Sun of 1898, 1900, 1905, and 1908. The paper, which gives a complete tabulation of the wave-lengths, heights, intensities, and other characteristics of all the spectral lines recorded on the eclipse plates and an interpretation of the phenomena in the light of modern theories of atomic structure, has been sent to the University Press to appear as Part I of Volume XVII of the *Publications of the Lick Observatory*. In connection with this study Mr. Menzel made several theoretical investigations of the contours of absorption lines in stellar spectra and of the generalized ionization formulae for stellar atmospheres which will be published in the near future.

Part II of Volume XVII of the *Publications of the Lick Observatory* will consist of a memoir on Halley's Comet at its apparition of 1909-1910, by Mr. Bobrovnikoff. This memoir, based upon the rich store of observational data in the possession of the Lick Observatory, was begun by Mr. Bobrovnikoff in 1927. It is the most important paper on cometary structure since Bredechin's classical memoirs on the subject in 1903.

Mr. J. H. Moore was placed in charge of the Crocker-Lick Observatory Expedition to observe the central eclipse of the Sun on April 28, 1930. In addition to the time actually spent at the camp by the members of the expedition, the design and construction of special apparatus, and preliminary expeditions to determine the precise location of the very narrow shadow path, absorbed a good deal of the time of various members of the staff during the year and, in particular, of Messrs. Moore, Menzel, and Jeffers. As a general account of the expedition has been published in the June, 1930, number of the *Publications of the Astronomical Society of the Pacific*, it is unnecessary to repeat it here. The spectrographic observations, which constituted the major part of the program, were entirely successful.

The personnel of the staff in residence at Mount Hamilton during the year is as follows: Astronomers: R. G. Aitken, W. H. Wright, J. H. Moore, R. J. Trumpler; Assistant Astronomers: F. J. Neubauer, H. M.

Jeffers, D. H. Menzel; Observing Assistant: G. F. Paddock; Computing Assistants: Miss Rebecca Jones, Miss Catherine Stillman. Holders of the Martin Kellogg, Alexander F. Morrison, and Lick Fellowships all resided in Berkeley for the whole or greater part of the year, an unusual circumstance. At the close of the academic year, Dr. W. W. Campbell became President Emeritus of the University, and Director and Astronomer Emeritus in the Lick Observatory. Dr. R. G. Aitken, Associate Director since July 1, 1923, was named Director, the appointment to date from July 1, 1930.

In closing this report it is a pleasure to acknowledge the enthusiasm and spirit of coöperation shown by every member of the staff.

R. G. AITKEN, *Associate Director.*

(To be continued.)

AN INVESTIGATION OF THE BINARY STAR 85 PEGASI

By JOHN S. ALLEN.

From the series of measures covering a period of fifty years of the binary star 85 Pegasi the elements of the orbit and the masses of the two components were obtained. The most recent set of orbital elements previous to this investigation were computed in 1915 by Van Biesbroeck. The companion has now completed two revolutions since Burnham first noted it as a double, thus making it desirable to get a definitive orbit that will describe the motion of the companion for several years to come. With this aim in mind the greatest care was taken to obtain as accurate results in each step as the original data would permit. The measures were examined for discordances by the usual interpolating curves. The measures retained were then grouped into a series of biannual means. These values were plotted as ordinates against the times as abscissae and a second set of interpolating curves were drawn among the plotted points. These curves gave slight corrections that were subtracted from the mean values that had been plotted. The corrected values were then plotted in polar coördinates. These points roughly determining the outline of the ellipse that represented the apparent orbit. An ellipse was drawn through the points and tested with a planimeter to determine the corrections necessary to make it satisfy the law of areas. The ellipse drawn satisfying this law and fairly representing the plotted points was considered as a final interpolating curve from which the elements were determined by use of the combination of the Glasenapp and Kowalsky method.

A second set of elements was computed by substituting the rectangular coördinates of the corrected values of the distance and position angle in the general equation for an ellipse and, by use of the Method of Least Squares, determining the most plausible values of the constants in the equation. These constants were then used in Kowalsky's equations to

determine the elements. In determining these elements we had no equation of condition imposed that the law of areas be satisfied as we had in the previous set. So in adopting a final set of elements a mean of the two sets was taken with a greater weight being assigned to the first set.

The results obtained are as follows:

$P = 26.86$ years
$T = 1910.34$
$a = 0.714$
$e = 0.272$
$i = 28° 12'$
$\lambda = 95° 59'$ (θ increasing)
$\Omega = 285° 4'$
$n = 13°.40$

Adopting the value 0".086 for the parallax of the system we found the total mass to be 0.794 of the mass of our sun. By making use of the series of measures covering a period of 74 years that tie up this system with a faint star in the same field of view, we determined the relative masses of the two components to be 0.286 times the mass of our sun for the bright primary of the system and 0.508 times the mass of our sun for the mass of the companion.

These values for the masses of the two components are contrary to the usual *a priori* expectations since the primary star is about five magnitudes brighter than its companion and in general the brighter star is the more massive. However, this is not an impossible case and taking into account the methods used in arriving at this conclusion we feel justified in considering it very probable. We also find that these results are in very good agreement with previous determinations of the masses of the two components.

The following table gives the orbital elements that have been derived by the various computers for 85 Pegasi:

Date	Computer	P	T	e	a	i	λ	Ω	n
1889	Schaeberle	26.70	1909.88	0.390	0.81	52.8	98.6	281.2	13.48
1892	Glasenapp	17.49	1884.00	0.35	0.96	68.6	70.3	306.1	16.14
1896	See	24.0	1883.80	0.388	0.890	55.6	265.4	116.5	15.0
1906	Bowyer and Furner	26.3	1883.5	0.46	0.82	15.1	266.1	115.6	....
1915	Van Biesbroeck	26.70	1909.88	0.39	0.81	52.8	98.6	281.2	13.48
1929	Allen	26.86	1910.34	0.272	0.714	28.2	96.0	285.1	13.40

The following table gives a list of the various determinations of the relative masses of the two components that have been made:

Computer	—Relative Mass— A	B	Method
Comstock	.38	.62	Measures of A and C.
Lewis and Turner	.25 .20	.75 .80	Meridian Circle observations.
Bowyer and Furner	.24 .15	.76 .85	Meridian Circle observations.
Bowyer and Furner	.26 .29	.74 .71	Measures of A and C.
Boss	.16 .49	.84 .51	Preliminary General Catalogue.
Van Biesbroeck	.36	.64	Measures of photographic plates.
Allen	.36	.64	Measures of A and C.

The following is an ephemeris for the apparent motion of 85 Pegasi for the next twenty years:

Date	θ	ρ
1930.0	260.8	0.76
1932.0	281.9	0.69
1934.0	310.3	0.58
1936.0	352.6	0.47
1938.0	46.1	0.48
1940.0	87.8	0.58
1942.0	116.7	0.68
1944.0	139.6	0.74
1946.0	159.9	0.77
1948.0	178.9	0.79
1950.0	197.1	0.82

UNIVERSITY OF MINNESOTA, 1930.

PLANET NOTES FOR APRIL, 1931

By CLIFFORD E. SMITH.

The *Sun* will be moving northeast from the central part of Pisces to the central part of Aries. On April 18 there will be a partial eclipse of the sun visible in Asia. The position of the sun on the first and last days of the month will be respectively: R.A. $0^h\,38^m$, Decl. $+4°\,5'$; R.A. $2^h\,25^m$, Decl. $+14°\,24'$.

The phases of the *Moon* will occur as follows:

Full Moon	April 2	at 2 P.M.	C.S.T.
Last Quarter	9	" 2 P.M.	"
New Moon	17	" 7 P.M.	"
First Quarter	25	" 8 A.M.	"

The moon will be at perigee on April 1 and on April 30, and at apogee on April 14. There will be a total eclipse of the moon on April 2 which will be visible in most of the eastern hemisphere but not in North and South America.

Mercury will be moving from eastern Pisces to central Aries. On April 20 its apparent motion among the stars will change from direct to retrograde. During the first part of the month Mercury will set about an hour after the sun. It will be brightest early in the month; its brightness at that time will be about equal to that of Mars during January. It will be at greatest elongation east on April 10, in conjunction with the moon on April 19, and at inferior conjunction on April 30.

Venus at the beginning of this period will be in Aquarius, and it will have moved to central Pisces by the end of April. It will continue as a morning star of brightness about magnitude —3.5, rising about two hours before the sun. Conjunction with the moon will occur on April 14.

Mars will be in Cancer moving from the western to the eastern part. It will be an evening star of magnitude about +1, and by the end of the month it will be near the meridian at 6:00 P.M., since quadrature east will occur early in May. Its distance from the earth at the end of April will be about 1200 million miles which is about double the distance which obtained in January. Conjunction with the moon will occur on April 25.

Jupiter will continue as an evening star in central Gemini of brightness about —2. It will be near the meridian about 6:00 P.M. early in the month, since quadra-

ture east will occur on April 2. It will be in conjunction with the moon on April 24.

Saturn will be a morning star in eastern Sagittarius of brightness about magnitude +1. During the middle of the month it will be on the meridian about 6:00 A.M., since quadrature west of the sun will occur on April 13. Conjunction with the moon will occur on April 10.

Uranus will be in Pisces near the sun in apparent position. Conjunction with the sun will occur on April 6.

Neptune will continue in the evening sky in Leo. During the middle of the month it will be on the meridian about 8:30 P.M. Conjunction with the moon will occur on April 27.

Occultations

VISIBLE AT WASHINGTON.

[From the *American Ephemeris.*]

Date 1931	Star	Mag.	IMMERSION Washington C.T. h m	IMMERSION a m	IMMERSION b m	IMMERSION Angle E from N °	EMERSION Washington C.T. h m	EMERSION a m	EMERSION b m	EMERSION Angle E from N °
April 3	621 B.Vir	6.4	23 27	—1.8	+0.5	99	0 31	—0.7	—1.3	336
4	40 H.Vir	5.1	3 58	—1.2	—1.9	146	4 59	—1.1	—1.3	270
5	40 B.Sco	5.4	22 49	—1.4	+2.3	68	23 30	+0.4	—1.3	346
6	48 B.Sco	4.9	2 4	..	..	183	2 34	..	..	228
8	*W* Sgr	4.3	2 21	—0.4	—0.7	149	3 13	—2.6	+1.8	230
9	183 B.Sgr	6.2	4 30	—2.2	+1.3	60	5 54	—2.4	—0.3	287
23	47 Gem	5.6	23 24	+0.9	—2.2	152	23 59	—0.1	—0.4	237
24	ω Cnc	6.1	17 54	—1.4	—2.5	144	19 3	—2.4	+0.1	256
28	β Vir	3.8	23 12	0.0	—2.8	178	23 57	—2.1	—0.9	261

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 or 300 miles of Washington. The procedure is as follows: Subtract the longitude of Washington (77°.1) from the longitude of the place in question; multiply the result, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude (38°.9) using *b*; apply the sum of the products, with its proper sign, to the Washington C.T., and obtain the predicted Washington Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to add 8.3 minutes to Washington Civil Time.

VISIBLE AT OMAHA AND VICINITY.

Date 1931	Star	Mag.	G.C.T. h m	*a* m	*b* m	P °
April 1	σ Leonis	4.2	4 36	—0.5	—2.4	168
29	27 B. Virginis	6.5	8 34	—0.3	—0.4	142

VISIBLE AT MOUNT HAMILTON AND VICINITY.

April 20	τ Arietis	5.1	3 48	+0.1	+1.2	87
24	134 B. Geminorum	6.5	(7 10)			
25	λ Cancri	5.9	8 22	0.0	+0.9	95
27	107 B. Leonis	6.3	3 17	—3.5	+1.2	68
27	37 Leonis	5.5	9 50	+0.1	—0.5	110
29	27 B. Virginis	6.5	8 36	0.0	—2.2	179

The approximate times for observers within 300 miles of Omaha can be found by using the constants *a* and *b*, given in the table, according to the formula

$$\text{G.C.T.} = \text{Predicted G.C.T.} + a\Delta\lambda + b\Delta\phi,$$

$\Delta\lambda$ and $\Delta\phi$ in this case being obtained by using the longitude (96°.0) and latitude (41°.3) of Omaha, and subtracting these, respectively, from the longitude and latitude of the place.

For observers within 300 miles of Mount Hamilton, California, the same rule is followed using the longitude (121°.7) and latitude (37°.3) of Lick Observatory.

Only disappearances are given. Since the reappearance of 107 B. Leonis will take place on the dark limb, some observers may be interested to predict and observe it.

CORRECTION.—A mistake was made in the prediction of the occultation of χ Tauri for March 25. The disappearance at Omaha was set down for $0^h\ 31^m$. It should be $1^h\ 24^m$.

The author would appreciate a word from observers either of criticism or of suggestion. How exact have these predictions been? While they are accurate only for places within 300 miles, by intelligent use they should give a fair approximation for observers anywhere in the United States except possibly those in the Southern States.

Creighton University Observatory. WM. CLETUS DOYLE, S.J.

METEOR NOTES

By CHARLES P. OLIVIER.

As usual, our annual report is not published until the March issue in order that our distant members may have full opportunity to send in their observations up to the end of the year. But before outlining briefly what the American Meteor Society accomplished in 1930, due acknowledgments must be made to certain organizations to which we are under many obligations. First of all, the Hydrographic Office of the U. S. Navy and the Marine Bureau of the U. S. Weather Bureau have both furnished to us very many valuable observations, chiefly made by ships' officers at sea. Next we owe thanks to the Science Editor of the Associated Press, to the editors of Science Service, Washington, D. C., and to the editor of The Week's Science, New York City, as well as to various local newspapers, for the widest publicity whenever this has been advantageous. Due to this, both for the Perseids of August and for the Leonids of November extensive observations were made all over the United States by persons casually interested. Publicity has also been of the utmost importance following the appearances of brilliant fireballs. Again close contact with Dr. W. J. Fisher, in charge of the extensive meteoric work at Harvard College Observatory and with Dr. C. C. Wylie of the University of Iowa, who is directing meteoric work in the Middle West, has led to the exchange of valuable information and data. Particularly the observations of the Perseid and Leonid showers, which had been directly reported to Harvard Observatory, were passed on to us for inclusion in our reports on these phenomena.

And finally the A.M.S. is most grateful to several observatories and to hundreds of individuals who, singly or in groups, have reported observations of either meteor showers or single bright meteors. The names of most of the former have already appeared in recent "Meteor Notes." Those of the latter will appear, from time to time, as reductions can be made concerning the particular object seen by

them. In the field of telescopic meteors, the very efficient aid of certain members of the A.A.V.S.O. has been received. It would tremendously advance this branch of our work if more A.A.V.S.O. members would follow the good example of the dozen who do report.

It is therefore fully realized that much of the success of our work is due to these organizations and persons who are giving unselfish help in advancing this branch of astronomy. In the name of the American Meteor Society, as well as his own, the writer desires to express here the heartiest appreciation and the hope for similar efficient assistance in the future.

Coming now to our Society, one of the new members, Gordon W. Ridley, Alameda, California, profiting by the exceptionally clear weather of his station, has made a record which will be hard indeed to surpass—namely 2010 meteors observed in one year. Every one is entered fully on the record sheets as to time and magnitude, and nearly all are plotted. The amount of hard work necessary to secure so many observations was very great indeed. B. C. Darling of Lansing, Michigan, and R. A. McIntosh of Auckland, New Zealand, follow with 855 and 681 respectively, practically all completely observed and plotted. As a general center of activity, Fort Worth, Texas, under the able leadership of O. E. Monnig, continues to have the largest local group of active members. Collectively they reported over a thousand meteors, Monnig personally being responsible for one-half of the total. Two other observers, F. W. Smith of Glenolden, Pennsylvania, and D. F. Waugh of Tokyo, Japan, each observed on a very large number of nights but local weather conditions and other factors kept them from seeing numbers of meteors comparable to their persistent efforts.

We are gradually gathering an active group of observers in the neighborhood of Flower Observatory, but the nearness of Philadelphia and other cities, with their smoke and lights, as well as much cloudy weather, all combine to cut down our results very greatly. However, a successful parallax campaign from three stations was carried out on August 11, 1930, the results of which are about ready for publication.

In the field of telescopic meteors, the writer feels that most astronomers do not understand its importance. The total number who report is so few, and results here will be almost proportionate to the data received. We are particularly grateful to Dr. H. F. Donner and Dr. M. K. Jessup of the Lamont-Hussey Observatory of the University of Michigan in South Africa. They had the use of a great telescope, in a splendid climate, and their success in seeing telescopic meteors has been phenomenal. In America, E. F. Marsh and L. C. Peltier have led the rest of us. Blanks, with full instructions for the work, will be gladly furnished to any observer on his application therefor. As telescopic meteors are not very often seen by any one observer, no one need fear being burdened by the few records he will have the chance to make annually.

Table I contains the results of our regular members; Table II the results of others who have kindly reported and whose names did not appear in "Meteor Notes" for November, 1930, or for January, 1931. The names of 68 individuals or groups reporting 2431 observations on the Perseids, mostly counts, will be found in "Meteor Notes" for November. The names of 39 individuals or groups reporting 1390 observations on the Leonids, mostly counts, will be found in "Meteor Notes" for January. It is impracticable to reprint all these names here. Table III contains the reports on telescopic meteors. In addition, 245 observations of single bright meteors or fireballs were received. No effort has been made to include in our totals reports by non-members when the individual reported for the

night of a shower, once in the year, and saw less than 5 meteors. Several whose names appear in Table II have since joined the Society as regular members. About sixty per cent of the 13,560 meteors reported were plotted; magnitudes are given for many more. All are available for the study of rates.

A.M.S. Bulletins No. 11 and No. 12 and Flower Observatory Reprint No. 8 have been or are being sent to all active members. Contact has been kept by the writer, through the Meteor Commission of the International Astronomical Union, with meteor work being carried on in other countries. In America, the work of Dr. W. J. Fisher and that of Dr. C. C. Wylie deserve special attention for their importance. The writer has assigned to every member of the staff of the Flower Observatory some special problem in meteoric astronomy, based upon data at hand. They have also assisted him in the routine connected with the Society. Despite this, the amount of data is so great that a special assistant whose whole time should be so devoted has become a necessity. Efforts are being made to secure from some research fund enough to pay such an assistant. Meantime the

TABLE I.

Name	Station	Nights	Meteors	Remarks
Abernathy, C.	Clearwater, Florida	6	54	
Anyzeski, V.	New Haven, Conn.	11	146	
Baker, R. F.	State College, Pa.	2	50	
Brown, R.	Forth Worth, Texas	6	79	
Bunch, S.	Knoxville, Tenn.	6	123	Including 31 by
Burch, P. R.	East Radford, Va.	2	32	[Mrs. Bunch
Burns, H. A.	Spring Valley, N. Y.	9	108	
Cope, T. D.	Wayne, Pennsylvania	1	49	
Daniel, R. T.	Ashville, N. C.	2	319	Including ass'ts.
Darling, B. C.	Lansing, Mich.	94	855	
Davis, C.	Evanston, Illinois	7	24	
Eaton, F. B.	East Point, Georgia	1	29	
Edwards, Mrs. W. H.	Fairhope, Alabama	3	154	
Flower Observatory,	Upper Darby, Pa.		20	Casuals only
Ford, C. B.	Ann Arbor, Mich.	6	90	
Hett, J. H.	Bronxville, N. Y.	1	90	
Klapperich, A.	Wilmette, Illinois	3	23	
La Paz, L.	Columbus, Ohio	7	127	
Logan, J. H.	Dallas, Texas	4	55	
McIntosh, R. A.	Auckland, N. Z.	13	681	
McKee, J. E.	Mt. Vernon, Ohio	5	52	
McVictor, D. & M. Van I.	Ocean City, N. J.	2	108	
Marsh, F. F.	Frederick, Md.	6	94	
Mehl, M.	Fort Worth, Texas	5	43	
Monnig, O. E.	Fort Worth, Texas	33	533	
Olivier, C. P.	Upper Darby, Pa.	8	113	
Ridley, G. W.	Alameda, California	80	2010	
Sanders, B.	Fort Worth, Texas	5	149	
Schafer, C. P.	Nashville, Tenn.	7	111	
Shinkfield, R. C.	Adelaide, S. Australia	10	129	
Smith, F. K.	Glenolden, Pa.	35	78	
Tomkins, T. K.	N. Glenside, Pa.	8	69	
Troyer, F. L.	Toronto, Canada	4	106	
Wamer, W. P.	Upper Darby, Pa.	3	38	
Waugh, D. F.	Tokyo, Japan	35	264	
Whitney, B. S.	Beaver, Oklahoma	7	88	Including two
Wilson, R. H.	Swarthmore, Pa.	15	204	[nights in 1929
Yanovsky, A. H.	Philadelphia, Pa.	3	40	
Six members reporting less than 20 each			64	
Total			7401	

writer does the best he can to prepare for publication such parts as prove practicable. But a systematic study of the maps for radiants, along with other things, will have to wait until more assistance can be procured.

The growth in membership has been steady, but of course many of those less interested soon drop out. The gains however far more than offset the losses. The annual dues are $1, payable at the beginning of the year. Names of persons who do not pay their dues and who further send in no observations or data to justify their membership in the Society will be dropped at the end of each year. The accuracy of the work is constantly improving and the importance of the results will increase proportionately. We can look forward with confidence to an active membership and a successful year for 1931, as 1930 was by far the best year of our Society's existence.

TABLE II.

Name	Station	Nights	Meteors	Remarks
Andrews, L. B.	Great Blue Hill, Mass.	1	143	
Apple, J. H.	Frederick, Maryland	1	27	
Durrett, J.	Fort Worth, Texas	1	92	
Hausman, Miss J. D.	Fort Worth, Texas	5	31	
Herman, Mrs. E. A. G.	Frederick, Maryland	1	15	
Kenan, J. L.	Havana, Cuba	1	30	Leonid epoch
Kent, Moore	University of Arkansas, Fayetteville, Arkansas	1	195	Geminid epoch
Komaki, K.	Wakayamaker, Japan	28	166	
Maria Mitchell Obs.,	Nantucket, Mass.	2	146	
Muñoz, J. L.	Buenos Aires, Argentine	5	77	
Olweiler, S. K.	Allentown, Pa.	1	39	
Smith, B. W.	Roanoke, Virginia	1	25	Perseids 1929
Stevens, W. B.	Santa Barbara, Calif.	4	69	Quadrantid
Tacubaya Observatory	Tacubaya, Mexico	2	763	Leonid epoch
Watson, P. S.	Baltimore, Maryland	1	51	
Total			1869	

TABLE III.—TELESCOPIC METEORS.

Anyzeski, V	New Haven, Connecticut	2	
Bouton, T. C. H.	St. Petersburg, Florida	8	
Buckstaff, R. N.	Oshkosh, Wisconsin	7	
Flower Observatory Staff	Upper Darby, Pa.	18	
Ford, C. B.	Ann Arbor Michigan	13	
Jessup, M. K.	Bloemfontein, S. Africa	53	
Marsh, F. F.	Frederick, Maryland	46	
Monnig, O. E.	Fort Worth, Texas	5	
Peltier, L. C.	Delphos, Ohio	62	1929 and 1930
Shinkfield, R. C.	Adelaide, S. Australia	4	
Smith, F. W.	Glenolden, Pa.	5	
Wilson, R. H.	Swarthmore, Pa.	1	
Total		224	

Grand Total of all meteors reported for 1930, with a few not included in 1929 report:

Table I	7401
Table II	1869
Table III	224
Perseid Epoch	2431
Leonid Epoch	1390
Fireballs	245
Grand Total	13,560

Flower Observatory, Upper Darby, Pennsylvania, 1931 February 17.

Fireballs Reported to the University of Iowa

The list of fireballs appearing in the November, 1930, issue of POPULAR ASTRONOMY closed with four reported on the evening of October 10, 1930, and referred to the report that on that evening a meteorite had damaged a Ford car near Crawfordsville, Indiana. This story has been more widely circulated than any meteor feature of recent years. Through November it was appearing in the daily newspapers and by the 29th in such weekly publications as the *Pathfinder* and the *Literary Digest*. Then certain Sunday features carried the story, and finally such monthly magazines as *Popular Science Monthly*, and *Science and Invention*. We have investigated the incident carefully and believe that the damage was probably not caused by a meteorite. A rather full discussion, with illustrations, will appear in the April issue of the *Scientific American*, and a similar article will be prepared for this journal. As before, the times given are 90th meridian and in the noon to noon reckoning. The hours are counted throughout the 24, 1:00 A.M. Civil Time being listed as 13:00 of the preceding Civil date.

On October 20, at 8:30, Mrs. Fay Cartner of Huron, S. D., then driving about thirty-five miles east of Pierre, observed a meteor which lighted up the countryside and left a trail of bluish smoke. On October 30 at 9:45, two university students observed a meteor bright enough to light up thin clouds. On November 12 at 7:00, R. N. Buckstaff of Oshkosh, Wisconsin, observed a meteor bright enough to cause shadows.

Several brilliant meteors were reported about the time of the Leonid shower. On November 14 at 23:00 (November 15 at 11:00 A.M. Civil Time, in broad daylight), C. R. Davis of Knoxville, Iowa, observed a brilliant meteor with a flaming trail. On November 16 at 11:00, an Iowa City druggist observed a meteor which lighted up the landscape. On the same night at 11:45, a brilliant meteor attracted attention in Dubuque, Iowa. Many were reported between 15:00 and daylight, the most spectacular observed at Iowa City perhaps being at 15:23, 15:43, and 16:08. These lighted up the sky like lightning, and left trails visible to the unaided eye for about ten minutes. At 16:47, or twenty-four minutes before sunrise, Mrs. Harry Allely of Randolph, Iowa, observed a brilliant meteor followed by a "wonderful blue trail." On November 23 at 13:50, Shirley A. Heck of Overland, Missouri, saw a meteor which illuminated the neighborhood "with a soft mellow light."

On December 8 at 5:00, there fell what was probably the most widely reported American meteor of 1930. It fell between sundown and the time the stars appeared, with clear weather in the surrounding district, and so was widely observed, although the Paragould meteor of February 16, and the Idaho meteor of December 24 were both undoubtedly brighter. It was reported from Iowa, Missouri, Arkansas, Mississippi, Tennessee, Kentucky, Indiana, and Illinois; and fell from the northeast, bursting with detonations over a point about fourteen miles southwest of Vandalia, Illinois. The country is there covered with brush and timber, and no meteorites were recovered.

On December 9 at 9:00, Mr. Marvin Nelson of Des Moines, Iowa, noticed a flash of light which he at first took to be the headlights of an automobile, but on turning he saw it was a meteor. Bright meteors were reported on December 10 and December 21, but the next spectacular object was the detonating meteor which fell near Lewiston, Idaho, on Christmas Eve, December 24 at 10:45 (9:45 105th meridian time). Reports were received from points in Montana about 400 miles away, and the detonations were pronounced in several neighboring towns. No meteorites have been recovered. The next bright meteor fell December 29 at 6:12,

and was reported from Iowa, Missouri, Illinois, and Michigan. This closes our list for 1930. The 1931 reports will be held for a later issue.

C. C. WYLIE.

University of Iowa, February 24, 1931.

The 1833 Leonids

Accounts of the famous Leonid shower of 1833 are not at all common and so we were quite interested when an elderly man came into the office to inquire about the Leonid shower this year (the approaching shower of 1931) and stated that he had often heard his father speak of the famous shower of 1833. Mr. H. T. Walter of Tipton, Iowa, who relates the incident was born in 1859. His father, Peter Walter, was born October 30, 1816, and died February 20, 1902. Peter Walter was, therefore, just past seventeen at the time of the great Leonid shower and this son, H. T. Walter, was born when he was forty-three years old. Peter Walter died when his son was forty-two and so the son had ample opportunity to hear the description of the Leonid shower many times. Mr. Walter's account follows:

"In 1833 Leonard Walter, my grandfather, was living near Easton, in North Hampton County, Pennsylvania. The farm was about a mile from Easton. A school teacher of German descent and presumably an elderly man, since he was referred to as 'the old German school teacher,' lived with my grandfather's family for nine years and was there at the time of the great Leonid shower. On that night (November 12, 1833) my father was awakened by the school teacher calling 'Pete! Get up, the last time has come,' and my father got up and looked out and the stars were falling like snow. He was then seventeen years old and this is the description as I have heard it many times. I have assumed that the old school teacher was awakened by the light from the falling stars but do not recall definitely that my father made that statement."

Mr. Walter gave us this account on the afternoon of Friday, February 13, 1931.

C. C. WYLIE.

University of Iowa, February 24, 1931.

Notable Meteors.—Our associate, Sr. Martin Dartayet [Sr. Dartayet is a member of the staff of the Government Observatory at La Plata] reports having observed, from La Plata, a curious meteor on the night of August 3, 1930, at 23:59 Argentine Standard Time (11:59 P.M.). This meteor appeared in the northwest about 25 degrees from the zenith and moved slowly 10 degrees to the west. Its brilliancy increased during the period of its visibility from mag. 2 to mag. —2, while the color, originally reddish, suddenly became *bluish-green* at the end of its course when apparently (and perhaps also in reality) it traversed a group of cirrus clouds. In this last part of its course there was also a rapid increase in brilliancy of approximately 1 magnitude. It left a trail visible for a few seconds.

In addition, our associate, Dr. Ulises Bergara, informs us of the observation of a fireball of great size from his observatory at Villa Devoto [a suburb of Buenos Aires] on September 27 at 8:25 P.M., Argentine Standard Time. It appeared near Altair and disappeared near Vega. Its brilliance was estimated as superior to that of Venus; its color was at the beginning red but changed to *green* in the final third of its course.

The following information concerning another notable meteor has been communicated to us through the intermediary of Dr. J. Hartmann, Director of the La Plata Observatory: Sr. Emilio Sáenz of Dolores, Province of Buenos Aires, observed at 1:07 A.M., November 17, an enormous fireball whose brilliancy was so

great as to irritate his eyes. This fireball crossed the sky from east to west, leaving behind it a trail which remained visible some 25 seconds. This fireball unquestionably pertains to the Leonids which become visible every year around November 14 and whose maximum activity, which occurs every 33 years, can be expected to occur around 1932-33. If other persons have observed this same meteor, they are requested to communicate the details to our Association.

(From *La Revista Astronómica*, Buenos Aires, November-December Issue, 1930, translated by Mr. Paul J. Hogan.)

A Bright Meteor.—While seated in a west window, in a darkened room Thursday evening between 5:45 and 5:50, there suddenly appeared from the south a large meteor. It appeared to be over Fort Hale and traveling north by a little east. It seemed very near in fact not much higher than East Rock. I could see it until it was about over Fort Wooster on Townsend Avenue. In size it was many times larger than the evening star and most of the time had quite a long tail. This occurrence was Thursday evening, January 22.

It was so huge that when I first saw it I thought it a plane on fire, however it was traveling much faster than a plane.

MRS. HERBERT H. SLOCOMBE.

387 Fort Hale Road, New Haven, Connecticut, January 28, 1931.

COMET NOTES

By G. VAN BIESBROECK.

For several months this cometary report has repeated itself without much diversity. No comets in reach of ordinary instruments; several very faint ones being kept track of by photographic exposures of increasing duration.

No information has been received as yet about the expected return of PERIODIC COMET ENCKE. It could not be found so far on plates exposed during the last month by the writer. This short-period comet is evidently still quite faint; it is only accessible during a short time after sunset so that no long exposures are possible before the region vanishes in the haze of the horizon. However, computation indicates gain in brightness so that the recovery may be expected any day.

The four faint comets mentioned last month as being watched by photographic means at Williams Bay have received further attention here with the unexpected result that one of them has shown a sudden outburst of activity: on February 10-11 PERIODIC COMET 1925 II (SCHWASSMANN-WACHMANN) appeared at least as bright as 13^M! It will be recalled that already in 1927, shortly after its discovery at Bergedorf, this comet showed a rapid drop in brightness which could not be accounted for by the distance relations; its orbit has the smallest known eccentricity among comets (0.14); it remains all the time at a great distance from the sun since its whole orbit is included between that of Jupiter and Saturn. The distance changes so little that as early as 1927 it appeared highly probable that here for the first time was a case of a comet observable all the way around its orbit. It was duly found again in the fall of 1928 and its magnitude stayed between 16th and 17th at that opposition. In 1929 the comet could not be seen on plates taken in November, which means that its brightness was then below 17^M, but one month later it was very conspicuous as a round nebulosity of brightness

$13^{M}.5$. But it did not remain long in this condition. One month later it had gone down to 15^{M}.

Last fall observations on this object were resumed in October and I write down here the magnitudes estimated from the plates secured with the 24-inch reflector at Williams Bay:

MAGNITUDE ESTIMATIONS OF COMET 1925 II.

		M			M
1930 Oct.	20	16.5	1931 Jan.	10	17.5
Oct.	22	16.5	Feb.	10	13.0
Nov.	23	15.0	Feb.	11	12.5
Dec.	16	17.0	Feb.	21	16.0
Dec.	28	17.0			

Except for a brightening up of at least 1^{M} in November, the comet has remained very faint until January but on February 10 it was hardly recognizable. Instead of a little nucleus surrounded by a very faint coma, as it usually appeared, it showed a large disk as if the nucleus had expanded, without any increase in the size of the coma, which was hardly visible. I regret not to have had an opportunity for visual observations at that time. Ten days later the comet had reverted to its former faintness and appearance. During these last months the distances of the comet from the sun and from the earth have changed inappreciably. What is the cause of this short-lived outburst in such an inconspicuous object, so far removed from its external source of energy? What curious internal catastrophe can account for a hundredfold change in brightness within a few days, when outside conditions remain unchanged as far as we can see? This is one more of the many unexplained phenomena that we encounter in the study of comets.

The other faint comets that remain under observation have behaved in a more normal way since last month:

PERIODIC COMET TEMPEL II fades more and more in the western sky and will soon be lost because of the approach of the sun. The coma has become still more diffuse which makes it very difficult to locate.

Good plates were again obtained (February 14) showing COMET 1927 IV (STEARNS) close to the ephemeris position and remaining nearly of the same brightness (17^{M}) as expected. In a few days the fourth year of visibility will be completed and at the same time this object will outdo all others known as far as visibility at the enormous distance of eleven astronomical units is concerned.

In the latter part of the night COMET 1930 *b* (BEYER) comes under good observing conditions. It appears as a minute nebulous spot of magnitude 14 to 15. Professor Leuschner sends (*Harvard Announcement Card* 147) the following continuation of the ephemeris computed by Bower:

1931 U.T.		α h m s	δ ° ′	M
March	4	18 41 10	+33 25	14.4
	12	45 41	34 07	
	20	49 06	34 51	
	28	51 22	35 38	
April	5	52 27	36 24	14.5
	13	52 18	37 10	
	21	50 56	37 52	
	29	48 20	38 30	
May	7	44 34	39 01	14.7
	15	18 39 45	+39 23	

from which it seems certain that the oject will be followed through the summer.

Mr. Noah W. McLeod of Christine, N. D., writes to the Editor to call attention to the small distance between the orbit of PERIODIC COMET 1930 *d* (SCHWASSMANN-WACHMANN) and that of the earth. "There is a very strong probability of a meteor shower connected with this comet. The earth passes the node of the comet's orbit on June 8, 14^h G.M.T. This determines the maximum of the shower, which in the United States will be invisible because of daylight, but which should be visible over the Pacific Ocean and in Japan." He further locates the expected radiants at $\alpha = 242°$, $\delta = +43°$ (Hercules) and expresses the hope that next June observers will be on the watch for a shower from that point. Evidently Mr. McLeod is unaware of the fact that on June 9 of last year Mr. K. Nakamura at Kyoto (Japan) already succeeded in recording a considerable number of meteors corresponding to the above radiant. The Japanese observer gives a detailed report about his observations in the *Monthly Notices of the R.A.S.*, Nov., 1930 (Vol. 91, p. 205). It will be of great interest to watch the further returns of this same shower.

A letter dated January 19 was received from Mr. K. Nakamura giving welcome particulars concerning the object that he found last November. It was at first called COMET 1930 *g* but other observers failed to locate the object in the computed position. Mr. Nakamura writes that he found the object as a long trail on a plate exposed on the Pleiades November 14. He identified it afterwards on a plate exposed the previous night in the same region. On November 15 he tried to see the object with the 30-cm Cooke refractor of the Kwasan Observatory (Kyoto) but he could only make out a doubtful nebulous object, which however he photographed with the 16-cm reflector carried by the same instrument. The next day (November 16) Mr. Shibata computed the parabolic orbit from the positions November 13, 14, and 15, and Mr. Yamamoto established the ephemeris, which was sent out at the same time as the first announcement, but which unfortunately proved to be incorrect. Mr. Nakamura adds that from the sharpness of the trail he called it an "object," instead of a comet but it was announced as a comet after the parabola seemed to represent the observations. It was quite apparent that the object was rapidly fading and it soon became difficult to follow. Further plates were exposed until November 29. Mr. Nakamura is now securing positions from about 20 plates available. It will be interesting to see if his results bring out a cometary or planetary orbit.

Williams Bay, Wisconsin, February 23, 1931.

VARIABLE STARS

Monthly Report of the American Association of Variable Star Observers for January, 1931

We welcome back to the ranks of active observers Messrs. Jacobsen, Kurtz, and Proctor. Also, Mr. Wares, a student at the University of Washington working under the direction of Mr. Jacobsen, contributes his first report to these columns.

Mr. D. B. Pickering of East Orange, New Jersey, who has already visited and described many of the foreign observatories, has started out to "do" the American observatories, both professional and amateur. The trip will occupy eight months and A.A.V.S.O. members, in particular, should not be surprised if they

Variable Star Observations Received During January, 1931.

Nov. 0 = J.D. 2426281; Dec. 0 = J.D. 2426311; Jan. 0 = J.D. 2426342.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
V Scl	R And	W Scl	W Cas	U Psc	U Per
000339	001838	*003833*	004958	011712	015254
293[13.3 Bl	316 7.4 Ah	283 13.0 Bl	275 9.7 Ch	338 14.1 L	326 8.5 BL
299[13.3 En	324 7.3 Jo	302 12.8 En	282 9.6 Jo	RZ Per	327 8.5 Pt
S Scl	327 7.0 Pt	Y Cep	291 9.2 Jo	012350	338 8.6 BL
001032	330 6.9 Ah	003179	295 9.5 Jo	303 10.2 Ch	341 8.4 BL
283 5.8 Bl	331 6.8 Ah	321 15.0 L	301 9.3 Jo	321 10.4 L	348 8.9 BL
293 6.8 Bl	331 7.0 Jo	α Cas	303 9.3 Jo	357 9.9 Al	350 8.6 BL
299 7.5 En	331 6.9 Ma	003656	307 9.0 Jo	359 10.4 Md	352 8.3 BL
299 6.9 Ht	332 6.9 Ah	349 2.6 Mc	302 9.8 Ch	R Psc	355 8.4 BL
303 7.0 Bl	333 7.0 Gy	358 2.4 Mc	321 8.9 Jo	012502	XX Per
305 7.0 Ht	334 6.9 Ah	U Cas	326 9.5 BL	292 9.2 Ch	015654
327 8.1 Pt	335 7.1 Ah	004047	327 8.9 Pt	327 10.0 Pt	291 7.9 Ch
328 7.9 Ht	339 7.0 Ah	307 11.4 Ch	331 8.7 Jo	331 10.3 Ah	S Ari
337 8.7 Ht	341 6.9 Ah	310 10.8 Kz	334 8.8 Jo	332 10.4 Ah	015912
X And	350 6.7 Gy	321 9.8 L	341 9.3 BL	357 11.4 Al	321 15.0 L
001046	350 7.0 Ma	326 10.0 Sf	343 8.7 B	RU And	R Ari
275 13.8 Ch	357 7.0 Al	327 9.3 Pt	348 9.0 BL	013238	021024
310[13.4 Kz	359 7.0 Ma	338 8.7 Sf	350 9.1 BL	293 11.9 Md	291 10.6 Ch
353[13.4 Bw	S Tuc	339 8.7 L	352 8.9 BL	302 11.8 Ch	311 9.5 Ch
T Cet	*001862*	349 8.5 Sf	353 9.1 Bw	307 11.5 Ch	319 9.6 L
001620	283 10.2 Bl	350 8.4 Md	355 8.9 BL	321 11.5 L	327 9.3 Pt
321 5.8 L	293 10.4 Bl	353 8.5 Sf	U Tuc	327 11.1 Pt	330 9.4 Ah
339 5.5 L	299 10.8 Ht	353 8.6 Bw	*005475*	335 10.7 Ma	331 9.4 Ah
T And	299 10.6 En	RW And	283 13.7 Bl	350 10.7 Ma	332 9.2 Ah
001726	303 10.7 Bl	004132	293 14.0 Bl	357 10.7 Al	334 9.0 Ah
307 12.8 Ch	305 10.8 Ht	275 10.4 Ch	299[13.7 En	359 10.7 Ma	335 8.3 Ma
310 12.7 Kz	328 12.1 Ht	292 9.9 Jo	303 14.0 Bl	Y And	335 8.4 L
327 12.3 Pt	337 12.6 Ht	293 9.8 Ch	305[12.9 Ht	013338	339 8.6 Ah
350 10.3 Gy	S Cet	295 9.8 Jo	337 13.3 Ht	273 11.4 Ch	341 8.5 Ah
T Cas	*001909*	301 9.3 Jo	Z Cet	302 10.5 Jo	350 8.4 Ma
001755	273 9.5 Ch	305 9.9 Md	*010102*	302 9.8 Ch	359 8.3 Ma
282 8.6 Jo	290 8.2 Ch	310 8.8 Kz	307 9.2 Ch	303 10.3 Md	W And
290 9.0 Ch	292 8.7 Jo	321 9.7 L	319 8.7 L	307 9.9 Ch	021143a
291 8.6 Jo	302 8.0 Jo	327 9.4 Pt	327 8.7 Pt	321 10.4 L	327 13.6 Pt
295 8.6 Jo	302 7.6 Ch	337 9.8 L	335 9.0 L	327 10.0 Pt	333[12.0 Gy
301 8.5 Jo	304 7.7 Jo	351 9.8 Md	354 10.5 Fe	335 10.5 Ma	350[12.2 Gy
303 8.6 Jo	319 7.7 L	357 10.2 Al	U Scl	350 10.9 Ma	T Per
307 8.5 Jo	324 8.0 Jo	V And	*010630*	359 12.3 Ma	021258
308 8.7 Ch	326 8.4 Sf	004435	283[13.2 Bl	X Cas	291 8.2 Jo
313 8.7 Ah	327 8.0 Pt	275 9.8 Ch	U And	014958	295 8.0 Jo
321 8.0 Jo	331 8.0 Jo	307 10.8 Ch	010940	282 10.5 Jo	301 8.3 Jo
321 8.2 L	335 8.3 Jo	310 11.3 Kz	321 12.2 L	291 10.8 Jo	303 8.6 Jo
327 8.2 Pt	339 8.1 L	X Scl	353 11.7 Bw	295 11.0 Jo	307 8.6 Jo
330 8.2 Ah	341 8.6 Sf	*004435*	357 10.9 Al	301 11.0 Jo	326 9.0 BL
331 8.4 Ah	349 8.9 Sf	283 10.7 Bl	UZ And	303 11.4 Jo	327 8.4 Pt
331 7.8 Jo	353 9.3 Sf	293 11.1 Bl	011041	307 11.7 Jo	329 8.4 Jo
334 7.7 Jo	354 9.3 Fe	303 11.0 Bl	275[13.1 Ch	321 12.0 Jo	331 8.7 Ah
334 8.4 Ah	T Scl	305 11.3 En	307 11.0 Ch	324 11.9 Bn	333 8.4 Jo
339 7.8 L	*002438a*	RR And	S Psc	327 12.2 Pt	338 8.7 BL
341 7.9 Ah	299[12.3 En	004533	011208	328 12.0 Jo	341 8.6 BL
357 7.2 Al	T Phe	307 11.7 Ch	321 14.7 L	332 12.0 Bn	348 8.6 BL
R And	*002546*	310 12.8 Kz	S Cas	337 12.0 Bn	350 8.7 BL
001838	283[13.6 Bl	357 9.0 Al	011272	348 12.1 Bn	352 8.7 BL
273 9.7 Ch	299[13.0 En	RV Cas	273[11.9 Ch	359 12.5 Bn	355 9.0 BL
290 8.5 Ch	305[13.0 Ht	004746a	U Psc	U Per	Z Cep
303 8.2 Jo	328[13.0 Ht	275[13.2 Ch	011712	015254	021281
311 7.7 Ch	337[13.0 Ht	307[13.9 Ch	321 13.7 L	291 8.0 Ch	273 11.0 Ch
315 7.3 Ah			327 14.3 Pt	292 8.6 Jo	291 11.8 Ch

VARIABLE STAR OBSERVATIONS RECEIVED DURING JANUARY, 1931.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
Z CEP	S PER	R TRI	X CET	T ERI	R RET
021281	021558	023133	*031401*	*035124*	*043263*
328 13.3 L	331 9.4 Ah	334 9.3 Ah	274 8.8 Ch	299 12.0 En	299 11.8 Ht
o CET	333 8.2 Jo	335 9.4 Ma	292 8.5 Ch	R TAU	300 11.9 Sl
021403	338 9.3 BL	339 9.3 Ah	295 9.0 Jo	042209	303 11.8 En
123 3.8 Sl	341 9.4 BL	341 9.4 Ah	302 8.9 Jo	305 12.2 Ch	305 11.6 Ht
127 3.7 Sl	348 9.3 BL	350 10.4 Sf	304 8.8 Jo	326 12.7 B	309 11.4 En
136 3.7 Sl	350 9.4 BL	350 10.0 Gy	321 9.0 Jo	350 12.2 Ma	309 11.5 Sl
152 3.7 Sl	352 9.6 BL	350 9.6 Ma	321 9.5 L	359 12.0 Ma	320 10.5 Sl
157 3.6 Sl	355 9.4 BL	355 10.5 Sf	324 9.5 Jo	W TAU	329 9.9 Ht
273 8.5 Ch	R CET	359 10.4 Ma	326 9.2 Sf	042215	330 9.8 Sl
291 8.2 Jo	*022000*	W PER	327 9.0 Pt	293 10.3 Ws	339 9.5 Sl
292 8.6 Ch	305 11.2 Ch	024356	331 9.4 Jo	301 12.0 Jo	X CAM
293 8.5 Ws	319 10.4 L	239 9.3 Jh	338 9.8 Sf	302 11.7 Jo	043274
295 8.5 Jo	335 7.6 L	291 9.2 Ch	338 9.7 L	304 11.0 Jo	273 8.4 Ch
299 8.8 En	349 7.5 Sf	291 8.6 Jo	349 10.4 Sf	305 10.7 Ch	294 10.4 Ch
301 8.5 Jo	353 7.6 Sf	295 8.6 Jo	353 10.7 Sf	321 11.0 L	321 12.6 L
303 8.6 Jo	354 8.1 Fe	301 8.5 Jo	Y PER	321 10.5 Jo	327 12.6 Pt
304 8.6 Jo	356 7.6 Bg	303 8.6 Jo	032043	321 10.2 B	330 12.2 L
307 8.6 Jo	RR PER	307 8.6 Jo	291 9.1 Ch	324 10.6 Jo	R DOR
308 9.0 Ch	022150	321 8.8 Jo	291 8.0 Jo	327 10.6 Pt	*043562*
309 8.6 Sl	272 9.8 Ch	327 8.5 Pt	295 7.9 Jo	331 10.6 Jo	283 5.5 Bl
319 8.9 L	291 10.4 Ch	329 8.4 Jo	301 8.2 Jo	332 9.7 Ws	290 5.6 Sl
321 8.7 Jo	321 11.7 L	331 8.3 Jo	303 8.4 Jo	334 10.7 Jo	299 5.5 Ht
321 8.9 Sl	327 11.7 Pt	332 9.1 Ws	307 8.5 Jo	337 9.5 Ws	300 5.7 Sl
326 9.0 Sl	R FOR	333 8.3 Jo	321 8.7 Jo	339 10.9 L	303 5.3 En
326 9.1 BL	*022436*	340 8.3 Ws	326 8.3 BL	340 9.5 Ws	303 5.6 Bl
327 9.2 Pt	283 11.0 Bl	349 8.7 Ws	327 8.1 Pt	349 9.5 Ws	305 5.5 Ht
330 9.0 Sl	293 11.3 Bl	350 8.9 Bw	329 8.3 Jo	350 10.4 Bw	309 5.4 Sl
330 9.2 Ah	303 11.3 Bl	360 9.1 Bw	330 9.1 Ah	355 10.4 Al	309 5.5 En
331 9.2 Ah	U CET	R HOR	331 9.0 Ah	360 10.4 Bw	320 5.6 Sl
331 9.2 Ma	*022813*	*025050*	332 9.2 Ah	S TAU	329 5.5 Ht
331 8.9 Jo	273 9.4 Ch	283 12.5 Bl	333 8.5 Jo	042309	330 5.7 Sl
332 9.2 Ah	292 11.1 Ch	290 12.3 Sl	334 9.2 Ah	305[12.0 Ch	337 5.5 Ht
333 9.4 Gy	327 12.7 Pt	293 12.5 Bl	338 8.4 BL	350[13.0 Ma	339 5.5 Sl
334 9.2 Ah	350 12.5 BL	299 12.6 Ht	339 9.3 Ah	359[13.0 Ma	R CAE
335 9.4 L	352 12.3 BL	299 12.6 En	341 8.6 BL	T CAM	*043738*
338 9.3 BL	RR CEP	300 12.5 Sl	348 9.0 BL	043065	283 9.3 Bl
339 9.0 Sl	022980	303 12.6 Bl	350 8.8 BL	295 9.7 Jo	299 9.8 Ht
339 9.3 Ah	327 10.0 Pt	305 12.8 Ht	352 8.4 BL	302 10.0 Jo	302 10.0 En
341 9.2 BL	328 10.1 L	310 12.6 Sl	355 8.8 BL	307 10.3 Jo	303 9.3 Bl
344 9.5 Wd	R TRI	320 12.6 Sl	R PER	321 11.0 L	305 9.9 Ht
348 9.1 BL	023133	328 12.8 Ht	032335	324 11.2 Jo	309 10.2 En
350 9.1 BL	272 6.7 Ch	330 12.5 Sl	305 13.3 Ch	326 11.5 BL	329 10.7 Ht
350 9.3 Gy	291 7.0 Ch	337 12.5 Ht	321 13.5 L	327 11.8 Pt	337 10.7 Ht
352 9.1 Wd	291 7.1 Jo	339 12.1 Sl	327 14.0 Pt	331 11.8 Jo	R PIC
352 9.1 BL	295 7.0 Jo	T HOR	335[14.1 Ma	338 11.7 BL	*044349*
353 9.7 Sf	301 7.6 Jo	*025751*	350[14.1 Ma	341 11.8 BL	283 7.6 Bl
355 9.0 BL	303 7.7 Jo	283 10.7 Bl	359 14.3 Ma	350 12.0 BL	299 7.6 Ht
359 9.3 Ma	307 8.0 Jo	293 10.2 Bl	NOV PER	352 11.9 BL	303 7.8 En
S PER	308 8.0 Ch	299 9.6 Ht	032443	355 12.1 BL	303 7.6 Bl
021558	316 8.6 Ah	299 9.7 En	327 13.0 Pt	RX TAU	305 7.6 Ht
291 8.6 Jo	321 9.0 Jo	303 9.5 Bl	T FOR	043208	309 7.7 En
295 8.5 Jo	327 9.1 Pt	305 9.1 Ht	*032528*	305 12.5 Ch	329 7.9 Ht
301 8.5 Jo	329 9.1 Jo	328 8.1 Ht	319 8.7 L	321 12.5 L	337 7.9 Ht
303 8.2 Jo	330 9.0 Ah	337 8.3 Ht	329 8.6 L	321 13.0 B	V TAU
304 8.4 Jo	331 9.1 Ah	U ARI	339 8.7 L	327 13.1 Pt	044617
326 9.4 BL	331 9.9 Jo	030514	U ERI	R RET	291 9.5 Ch
327 9.0 Pt	332 9.2 Ah	305[13.5 Ch	*034625*	*043263*	327 11.2 Pt
329 8.2 Jo	333 9.4 Gy	321 14.8 L	321 13.7 L	290 12.4 Sl	347 12.9 Mg

VARIABLE STAR OBSERVATIONS RECEIVED DURING JANUARY, 1931.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

R ORI
045307
292 9.8 Ch
301 9.3 Jo
321 9.2 L

R LEP
045514
282 6.4 Jo
290 5.8 Sl
292 5.8 Ch
300 5.8 Sl
301 6.6 Jo
309 5.7 Sl
320 5.6 Sl
321 6.5 Jo
321 6.2 L
326 5.5 Sl
327 6.0 Pt
330 5.6 Sl
331 6.3 Jo
334 6.0 Jo
339 5.5 Sl
339 5.7 L
350 5.7 Ma

V ORI
050003
292 9.7 Ch
321 10.7 L
327 10.2 Pt
330 11.0 Ah

T LEP
050022
283 10.5 Bl
302 10.8 En
303 10.3 Bl
309 10.6 En
327 10.0 Pt

S PIC
050848
283 11.2 Bl
299 9.6 Ht
303 9.1 En
303 9.3 Bl
305 8.9 Ht
309 8.3 En
329 6.8 Ht
337 7.1 Ht

R AUR
050953
305 10.9 Ch
327 12.3 Pt

T PIC
051247
283 10.0 Bl
299 12.0 Ht
303 11.8 En
303 12.1 Bl
305 12.0 Ht
309 12.5 En

NOV TAU
051316
329 14.5 L

T COL
051533
283 11.3 Bl
299 10.8 Ht
302 10.1 En
303 10.1 Bl
305 10.4 Ht
309 10.0 En
329 8.8 Ht
337 8.4 Ht

S AUR
052034
292 9.8 Ch
301 8.7 Jo
304 8.6 Jo
304 8.6 Ch
324 8.7 Jo
327 8.3 Pt
328 8.8 Jo
331 8.6 Jo
333 8.6 Jo
351 9.5 Mc

W AUR
052036
327 13.8 Pt
329 14.2 L

S ORI
052404
305 10.4 Ch
327 12.2 Pt

T ORI
053005a
282 10.8 Jo
295 11.0 Jo
301 11.5 Jo
304 11.3 Jo
305 10.0 Ch
319 10.3 L
321 10.3 L
321 10.1 Jo
324 10.7 Jo
325 10.2 L
326 10.7 Pt
327 10.7 Pt
328 10.7 Jo
329 10.2 L
330 10.3 L
330 10.2 L
331 10.7 Jo
333 11.5 L
334 11.0 Jo
334 10.9 Pt
338 10.9 L
339 11.4 L
340 10.6 Ws
349 10.2 Ws
349 10.8 Pt

T ORI
053005a
350 10.9 Pt
351 10.8 Pt
352 10.6 Pt

AN ORI
053005t
333 11.7 L
339 11.6 L

S CAM
053068
294 8.8 Ch
327 8.5 Pt
340 8.5 Ws

RR TAU
053326
319 11.2 L
321 11.1 L
325 12.0 L
326 12.4 B
328 11.6 L
329 11.2 L
330 10.9 L
333 10.9 L
337 11.7 L
338 11.6 L
339 11.7 L

RV AUR
053337
304 11.6 Ch
327 11.8 Pt
335 12.1 Pc
347 12.7 Mg
349 12.9 Mg

U AUR
053531
327 12.8 Pt
328 13.0 L
328 13.0 L
349 12.3 B

SU TAU
054319
292[12.1 Ch
304[13.3 Ch
310[13.8 Kz
319[13.3 L
321[13.8 B
325 13.8 L
326[13.4 B
327[12.1 Pt
329 14.0 L
330 14.0 L
331 13.5 Ma
333 13.7 L
334[12.1 Pt
337 13.3 L
338 13.2 L
339 13.3 L
341[11.5 Pt
342[12.1 Pc

SU TAU
054319
349[12.2 Pc
350 13.5 Pt
351 13.2 Pt
352 12.5 Pt

S COL
054331
283 10.8 Bl
299 11.4 Ht
303 11.4 En
303 11.7 Bl
305 11.8 Ht
309 11.5 En
329 12.6 Ht
337 12.5 Ht

Z TAU
054615a
329 13.8 L

RU TAU
054615c
329 12.8 L

R COL
054629
283 9.0 Bl
299 9.3 Ht
303 10.1 En
303 9.4 Bl
305 9.9 Ht
309 10.4 En
329 11.1 Ht
337 11.7 Ht

α ORI
054907
300 0.1 Sl
320 0.2 Sl
326 0.3 Sl
329 0.3 L
333 0.2 Sl
349 0.4 Mc
351 0.4 Mc
358 0.4 Mc

U ORI
054920a
274 6.6 Ch
291 6.2 Sl
295 6.3 Jo
300 6.0 Sl
301 6.5 Jo
302 6.0 Ch
304 6.0 Jo
307 6.2 Ch
309 6.1 Sl
313 6.5 Ah
315 6.3 Ah
320 6.3 Sl
321 6.6 Jo
326 6.4 Sl
327 6.7 Pt
330 6.5 Sl

U ORI
054920a
330 6.9 Ah
331 6.9 Ah
331 6.9 Jo
332 7.0 Ah
334 7.0 Ah
335 7.1 Ah
335 7.0 Jo
338 7.4 Wd
339 7.3 Ah
339 6.7 Sl
341 7.4 Ah
344 7.8 Wd
352 8.0 Mc

V CAM
054974
329 14.0 L

Z AUR
055353
302 10.6 Jo
304 10.5 Jo
324 10.4 Jo
326 10.9 B
326 10.0 Pt
327 10.1 Pt
328 10.0 Pt
334 9.7 Pt
341 10.0 Pt
349 9.7 Pt
350 9.7 Pt
351 9.7 Pt
352 9.8 Pt
352 9.5 Mc

R OCT
055686
283 11.0 Bl
299 11.1 Ht
303 11.0 En
303 11.0 Bl
305 11.1 Ht
328 11.6 Ht
337 11.6 Ht

X AUR
060450
280 8.1 Ch
295 11.8 Ch
311 12.1 Ch
321 13.0 L
327 12.2 Pt
335 10.0 Pc

V AUR
061647
321 12.2 L

V MON
061702
307 10.9 Ch
327 11.8 Pt

V MON
061702
348 12.8 Mg

AG AUR
062047
321 10.4 L
337 9.9 L

R MON
063308
327 11.8 Pt
349 12.7 Mg

NOV PIC
063462
292 8.3 En
299 8.5 Ht
305 8.4 Ht
309 8.2 En
329 8.4 Ht
337 8.5 Ht

S LYN
063558
313 11.2 Ch
321 12.6 L
327 12.3 Pt

X GEM
064030
306 9.7 Bn
324 8.6 Bn
331 8.5 Ma
332 8.3 Bn
336 8.1 Bn
343 7.8 Bn
348 7.7 Bn
351 7.8 Bn
353 7.5 Bw
359 7.8 Bn

Y MON
065111
307 9.7 Ch
321 9.1 L
327 9.0 Pt
331 8.8 Ma

X MON
065208
321 8.4 L

R LYN
065355
313 10.3 Ch
329 10.8 L

Z CMA
065911
291 10.0 Sl
300 9.9 Sl
309 10.0 Sl
320 9.9 Sl
330 10.0 Sl
339 10.0 Sl

V CMI
070109
307 10.8 Ch

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
V CMi	V GEM	U PUP	RX UMA	Z VEL	R UMA
070109	071713	*075612*	090567	*094953*	103769
326 11.7 Pt	322 13.8 L	350[12.5 Bw	322 11.4 L	299 8.5 Ht	282 7.8 Jo
329 11.6 L	S CMi	R CNC	RW CAR	303 8.9 Bl	291 7.9 Jo
350 12.3 Bw	072708	081112	*091868*	305 8.9 En	295 8.0 Jo
360 12.8 Bw	294 8.1 Ch	326 11.3 Pt	299[12.8 Ht	305 8.7 Ht	301 8.1 Jo
R GEM	301 8.8 Jo	343 10.5 Pc	303[12.8 Bl	329 9.4 Ht	303 8.1 Jo
070122a	321 9.8 Jo	V CNC	305[12.8 En	337 9.7 Ht	307 8.2 Jo
294 9.1 Ch	326 9.8 Pt	081617	337[12.8 Ht	V LEO	311 8.5 Ch
301 8.6 Jo	335 10.0 Pc	313 9.1 Ah	Y VEL	095421	313 8.7 Ah
304 8.6 Jo	354 10.8 Fe	326 8.4 Pt	*092551*	312 9.3 Ch	321 8.6 Jo
313 8.0 Ah	T CMi	328 8.4 Gy	299[12.9 Ht	341 10.9 Pt	324 8.8 Jo
315 7.9 Ah	072811	329 8.2 L	303[12.9 Bl	RR CAR	328 9.0 Jo
321 7.7 Jo	311 11.6 Ch	330 8.4 Ah	305[12.9 Ht	*095458*	330 8.9 Ah
324 8.0 Jo	329 13.5 L	331 8.2 Ah	329[12.9 Ht	299 8.0 Ht	331 9.0 Ah
326 7.3 Pt	S VOL	334 8.1 Ah	337[12.9 Ht	305 8.0 Ht	332 9.2 Ah
330 7.7 Ah	*073173*	341 8.0 Ah	R CAR	329 8.3 Ht	333 9.3 Jo
331 7.8 Ah	283[12.8 Bl	RT HYA	*092962*	337 8.4 Ht	333 9.0 Gy
331 7.7 Jo	299[13.2 Ht	*082405*	290 4.4 Sl	RV CAR	334 9.3 Ah
332 7.8 Ah	303[12.8 En	341 8.0 Pt	299 4.8 Ht	*095563*	339 9.5 Ah
334 7.7 Jo	337[13.2 Ht	R CHA	300 4.9 Sl	299[13.1 Ht	341 9.5 Ah
334 7.8 Ah	U CMi	*082476*	303 5.3 En	303[13.1 Bl	341 9.0 Pt
335 7.7 Ah	073508	299 8.7 Ht	303 5.5 Bl	305[13.1 Ht	345 9.4 Pc
339 7.8 Ah	313 8.7 Ch	303 8.7 En	305 5.4 Ht	329[13.1 Ht	350 9.8 Mc
341 7.7 Ah	329 8.0 L	303 7.8 Bl	306 6.0 En	337[13.1 Ht	358 9.9 Mc
Z GEM	326 8.2 Pt	305 8.7 Ht	309 5.6 Sl	S CAR	V HYA
010122b	S GEM	309 9.0 En	320 6.2 Sl	*100661*	*104620*
326 12.4 Pt	073723	328 9.0 Ht	326 6.3 Sl	290 5.9 Sl	312 6.8 Ch
TW GEM	294 9.0 Ch	337 9.2 Ht	329 6.3 Ht	299 6.2 Ht	323 7.0 L
070122c	301 8.8 Jo	U CNC	330 6.5 Sl	300 6.3 Sl	341 6.9 Pt
326 8.0 Pt	304 8.7 Jo	083019	337 7.0 Ht	303 6.5 En	W LEO
R CMi	321 8.9 Jo	329 9.7 L	X HYA	303 6.4 Bl	104814
070310	326 9.5 Pt	331 10.4 Ma	*093014*	305 6.5 Ht	329 12.4 L
307 9.8 Ch	328 9.4 Jo	S HYA	341 8.3 Pt	309 6.6 Sl	341 13.3 Pt
326 11.0 Pt	331 9.3 Jo	084803	Y DRA	320 6.9 Sl	RS CAR
329 10.8 L	335 9.3 Jo	313 8.7 Ch	093178	326 7.2 Sl	*110361*
349 10.3 Pc	343 9.6 Pc	330 9.8 Ah	329 12.0 L	329 8.0 Ht	300[12.3 Sl
352 10.5 Sf	W PUP	341 10.4 Pt	R LMi	337 8.3 Ht	326[12.3 Sl
R VOL	*074241*	T HYA	093934	339 7.9 Sl	S LEO
070772	283 8.5 Bl	*085008*	333[11.6 Gy	Z CAR	110506
299 12.2 Ht	299 8.2 Ht	329 9.2 L	341 12.6 Pt	*101058a*	312 10.8 Ch
303 12.2 En	303 8.7 En	341 9.0 Pt	RR HYA	303 12.3 Bl	329 10.9 L
305 12.2 Ht	303 8.5 Bl	T CNC	*094023*	329 11.6 Ht	341 11.1 Pt
328 10.9 Ht	305 9.0 Ht	085120	329 14.0 L	337 11.6 Ht	343 10.2 Ma
337 10.4 Ht	329 11.2 Ht	341 9.4 Pt	R LEO	W VEL	RY CAR
L$_2$ PUP	337 11.7 Ht	T PYX	094211	*101153*	*111561*
071044	T GEM	*090031*	282 8.8 Jo	303[13.0 Bl	305[13.1 Ht
290 4.8 Sl	074323	303 [t Bl	311 10.2 Ch	329[13.0 Ht	329[13.1 Ht
300 4.9 Sl	294 9.2 Ch	V UMA	328 9.0 Jo	337[13.0 Ht	337[13.1 Ht
309 5.2 Sl	321 8.5 Jo	090151	330 9.3 Ah	u HYA	RS CEN
320 5.1 Sl	326 8.6 Pt	322 10.1 L	331 9.3 Ah	*103212*	*111661*
326 4.9 Sl	328 8.8 Jo	349 10.3 Sf	331 9.1 Jo	329 5.4 L	305 11.2 Ht
330 4.6 Sl	330 8.7 Ah	351 9.8 Mc	334 9.3 Ah	RZ CAR	329 8.8 Ht
332 4.5 Sl	331 8.7 Jo	353 10.3 Sf	341 8.5 Pt	*103270*	337 8.3 Ht
339 4.2 Sl	331 8.3 Ma	358 9.6 Mc	343 8.5 Pc	299[13.1 Ht	X CEN
RR MON	331 8.4 Ah	W CNC	352 9.3 Sf	305[13.1 Ht	*114441*
071201	334 8.7 Ah	090425	Y HYA	329[13.1 Ht	305 10.5 Ht
307[13.2 Ch	335 8.8 Jo	329 13.3 L	*094622*	337[13.1 Ht	329 11.1 Ht
	341 9.0 Ah	335[12.8 Pc	341 6.4 Pt		337 11.4 Ht
	353 9.2 Bw				

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
AD CEN	RS UMA	V CVN	R CEN	Y LIB	R CRB
114858	123459	131546	*140950*	*150605*	154428
305 9.5 Ht	295 9.5 Jo	351 7.7 GD	289 6.9 Sl	341 9.5 Pt	329 6.0 L
329 9.3 Ht	301 9.3 Jo	V VIR	292 7.1 Bl	S LIB	330 6.0 L
337 9.3 Ht	302 9.3 Bn	*132202*	305 7.6 Ht	*151520*	337 5.9 L
W CEN	304 9.0 Jo	330[13.4 L	333 7.3 Sl	330 9.7 L	341 6.1 Pt
115058	306 9.3 Bn	343[12.5 Ma	337 7.6 Ht	S SER	343 6.0 Mg
305 11.0 Ht	311 9.6 Ch	R HYA	U UMI	151714	X CRB
329 12.8 Ht	321 9.0 Jo	*132422*	141567	322 10.6 L	154536
337 13.0 Ht	324 9.8 Bn	311 6.6 Ch	292 12.0 Jo	331 10.8 Ma	321 9.5 L
SU VIR	331 9.9 Jo	322 6.5 L	324 12.0 Jo	343 11.4 Ma	341 8.9 Pt
120012	337 10.4 Bn	331 5.4 Sl	341 12.5 Pt	S CRB	343 8.5 Ma
312 12.6 Ch	341 10.3 Pt	333 5.3 Sl	351 12.0 Pc	151731	R SER
341 13.2 Pt	343 10.5 Ma	337 4.8 Ht	S BOO	273 8.7 Ch	154615
343[12.5 Ma	348 10.8 Bn	341 5.2 Pt	141954	291 8.3 Jo	341 7.2 Pt
T VIR	349 11.0 Pc	S VIR	261 9.0 Ch	295 8.2 Jo	V CRB
120905	359 11.6 Bn	*132706*	282 8.8 Jo	312 8.5 Ch	154639
329 9.8 L	S UMA	311 12.0 Ch	291 8.6 Jo	341 8.6 Pt	341 8.5 Pt
341 9.5 Pt	123961	333 12.3 Sl	295 8.5 Jo	RS LIB	R LIB
R CRV	282 8.4 Jo	341 12.0 Pt	301 8.7 Jo	*151822*	*154715*
121418	291 8.3 Jo	RV CEN	330 10.6 L	330 11.4 L	337[10.5 L
329 9.1 L	295 8.3 Jo	*133155*	341 11.3 Pt	RU LIB	RR LIB
331 9.1 Sl	301 8.0 Jo	305 7.8 Ht	RS VIR	*152714*	*155018*
341 9.4 Pt	304 8.0 Jo	337 7.7 Ht	142205	330 9.1 L	337 9.3 L
SS VIR	311 8.1 Ch	T UMI	329 8.6 L	R NOR	343 9.3 Ma
122001	313 7.6 Ah	133273	V BOO	*152849*	Z CRB
329 7.4 L	315 7.7 Ah	330 13.6 L	142539a	282 9.8 Bl	155229
T CVN	316 7.6 Ah	T CEN	282 8.0 Jo	292 10.2 Bl	337 13.6 L
122532	321 7.4 Jo	*133633*	311 8.3 Ch	W LIB	U SER
312 11.0 Ch	330 7.7 Ah	331 6.0 Sl	331 8.6 Ah	*153215*	160210
341 10.5 Pt	331 7.9 Ah	337 6.2 Ht	334 8.7 Ah	330 12.0 L	341 11.3 Pt
Y VIR	331 7.7 Jo	RT CEN	341 8.5 Pt	S UMI	343 9.8 Ma
122803	332 7.5 Ah	*134236*	R CAM	153378	SX HER
329 10.1 L	334 7.6 Ah	337 11.7 Ht	142584	261 8.8 Ch	160325
343 9.8 Ma	339 7.7 Ah	R CVN	294 10.8 Ch	292 9.3 Jo	321 7.7 L
U CEN	341 7.9 Ah	134440	R BOO	294 9.6 Ch	337 8.5 L
122854	341 8.2 Pt	312 11.2 Ch	143227	301 9.5 Jo	341 8.1 Pt
305 8.5 Ht	343 8.1 Ma	341 10.4 Pt	341 12.4 Pt	321 10.5 Jo	W SCO
329 9.3 Ht	349 8.5 Pc	RX CEN	Y LUP	329 10.6 Jo	*160519*
337 9.5 Ht	RU VIR	*134536*	*145254*	330 10.7 Ah	266[12.6 Bl
T UMA	124204	337 9.7 Ht	282 9.4 Bl	331 10.9 Ah	RU HER
123160	330 12.0 L	T APS	292 9.7 Bl	332 10.8 Jo	160625a
330 9.8 Ah	341 11.8 Pt	*134677*	S APS	341 10.5 Pt	337 12.0 L
331 9.8 Ah	U VIR	282 12.8 Bl	*145071*	R CRB	343 11.9 Ma
332 9.8 Ah	124606	292[12.7 Bl	282 10.0 Bl	154428	W CRB
334 9.7 Ah	330 8.1 L	305[12.7 Ht	292 10.0 Bl	270 6.1 Ch	161138
339 9.5 Ah	341 8.1 Pt	337[13.2 Ht	299 10.0 Ht	273 6.1 Ch	292 8.5 Jo
341 9.3 Ah	RV VIR	Z BOO	305 10.0 Ht	280 6.1 Ch	326 9.0 Pt
341 9.2 Pt	*130212*	140113	311 10.0 Bl	282 6.0 Jo	V OPH
343 9.1 Ma	329[13.8 L	330 14.2 L	337 10.0 Ht	291 6.2 Jo	*162112*
349 8.5 Pc	U OCT	343 13.0 Ma	RT LIB	292 6.2 Jo	261 8.8 Ch
R VIR	*131283*	Z VIR	*150018*	294 6.4 Ch	337 7.2 L
123307	292[13.2 Bl	*140512*	341 11.7 Pt	301 6.0 Jo	341 7.6 Pt
341 8.8 Ws	299[12.9 Ht	322 11.1 L	T LIB	303 6.0 Jo	U HER
341 10.6 Pt	305[13.2 Ht	RU HYA	*150519*	304 6.0 Jo	162119
343 11.4 Ma	328 12.9 Ht	*140528*	330 11.1 L	312 6.3 Ch	261 10.4 Ch
RS UMA	337 12.4 Ht	337 12.1 Ht	341 11.1 Pt	313 6.3 Ch	290 7.8 Ch
123459	V CVN	R CEN	Y LIB	321 6.1 L	291 7.5 Jo
282 10.1 Jo	131546	*140950*	*150605*	322 6.1 L	295 7.3 Jo
291 9.5 Jo	326 7.5 GD	282 7.0 Bl	322 10.1 L	328 6.1 L	301 7.2 Jo

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
U HER	RS SCO	RU OPH	T HER	X OPH	ST SGR
162119	*164844*	172809	180531	183308	*185512a*
303 7.5 Jo	282 11.1 Bl	324 10.4 Pt	324 9.1 Pt	291 8.5 Jo	263 9.3 Ch
307 7.4 Jo	292 11.2 Bl	RU SCO	324 8.6 Jo	294 8.8 Ch	294 10.6 Ch
341 7.2 Pt	302 11.2 Bl	*173543*	331 8.4 Jo	295 8.5 Jo	323 12.0 L
SS HER	RR SCO	283 8.7 Bl	331 8.6 Ah	301 8.5 Jo	R CRA
162807	*165030a*	292 9.0 Bl	332 8.4 Ah	308 8.6 Jo	*185537a*
322 9.5 L	282 10.6 Bl	292 9.4 En	333 8.4 L	321 8.5 Jo	290 13.8 Sl
337 10.1 L	289 11.3 Sl	298 9.8 En	334 8.5 Jo	324 8.6 Jo	292 13.3 Bl
341 11.6 Pt	292 10.8 Bl	302 9.1 Bl	W DRA	329 8.7 L	299 12.7 Ht
W HER	RV HER	SV SCO	180565	RS DRA	305 12.5 Ht
163137	165631	*174135*	330 10.3 L	184074	T CRA
261 9.5 Ch	275 10.2 Ch	283 10.4 Bl	X DRA	274 10.8 Ch	*185537b*
273 8.4 Ch	291 10.4 Jo	292 10.8 Bl	180666	294 11.4 Ch	290 13.5 Sl
291 8.0 Jo	291 11.5 Ch	292 11.0 En	330[14.1 L	303 11.3 Ch	292 13.3 Bl
294 7.9 Ch	295 11.4 Jo	298 11.5 En	TV HER	RY LYR	299 12.7 Ht
301 8.1 Jo	301 11.8 Jo	302 11.2 Bl	181031	184134	Z LYR
302 8.1 Ch	303 11.8 Jo	W PAV	333 10.2 L	295[13.3 Ch	185634
303 7.8 Jo	324 13.6 Pt	*174162*	RY OPH	329 14.5 L	263 11.3 Ch
304 8.2 Jo	333 13.3 L	283 10.8 Bl	181103	R SCT	295 13.1 Ch
307 8.4 Jo	RT SCO	292 11.2 Bl	289 10.6 Sl	*184205*	333 14.3 L
321 8.8 Jo	*165636*	292 11.4 En	W LYR	263 6.1 Ch	SU SGR
324 9.2 Jo	282 9.3 Bl	298 11.8 En	181136	272 6.1 Ch	*185722*
324 9.0 Pt	292 9.5 Bl	299 11.5 Ht	291 11.8 Jo	275 6.2 Ch	299 8.5 Ht
343 9.4 Ma	302 9.4 Bl	303 11.7 Bl	295 11.7 Jo	289 6.2 Sl	305 8.3 Ht
R UMI	— DRA	305 12.3 Ht	301 10.4 Jo	291 5.8 Jo	RT LYR
163172	165752	311 12.3 Bl	304 10.0 Jo	293 6.0 Ch	185737
302 9.8 Jo	335 10.0 L	U ARA	307 9.5 Jo	295 6.0 Jo	263 10.5 Ch
307 10.0 Jo	RT HER	*174551*	321 9.2 Jo	301 5.8 Jo	295 12.2 Ch
321 10.2 Jo	170627	292 11.3 En	322 9.1 B	302 5.8 Ch	333 13.5 L
331 10.5 Jo	275 10.1 Ch	298 10.8 En	324 8.9 Jo	303 6.0 Jo	R AQL
335 10.6 Jo	294 9.6 Ch	299 10.8 Ht	324 9.0 Pt	308 5.7 Ch	190108
R DRA	324 9.6 Pt	305 9.3 Ht	328 8.9 L	312 5.7 L	263 10.4 Ch
163266	333 10.4 L	T DRA	331 8.3 Jo	323 5.0 L	290 8.3 Ch
261 10.4 Ch	RW SCO	175458a	331 8.7 Ah	326 5.6 Pt	308 7.4 Ch
282 8.4 Jo	*170833*	304 11.1 Ch	332 8.5 Ah	327 5.5 Pt	316 7.5 Ah
292 8.0 Jo	282 10.2 Bl	UY DRA	333 8.3 Jo	329 5.2 L	326 7.0 Pt
294 8.0 Ch	292 10.8 Bl	175458b	334 8.6 Ah	339 4.9 L	V LYR
304 7.6 Jo	302 10.4 Bl	304 10.8 Ch	335 8.4 Jo	NOV AQL	190529a
307 7.5 Jo	Z OPH	RY HER	339 8.5 Ah	184300	263 12.8 Ch
313 7.6 Ah	171401	175519	RV SGR	263 10.7 Ch	RX SGR
316 7.9 Ah	341 10.2 Pt	324 11.3 Pt	*182133*	291 10.4 Jo	*190818*
321 7.6 Jo	RS HER	333 10.8 L	292 13.6 Bl	292 10.6 Ch	263[13.1 Ch
324 7.5 Pt	171723	V DRA	298[12.4 En	295 10.5 Jo	290[13.1 L
328 7.7 Jo	291 8.3 Jo	175654	SV HER	301 10.6 Jo	299[12.7 Ht
330 7.9 Ah	295 8.5 Jo	304 11.5 Ch	182224	326 11.7 Pt	305[12.7 Ht
331 8.0 Ah	301 8.5 Jo	324 10.7 Pt	294 11.0 Ch	RX LYR	RW SGR
331 7.6 Jo	316 9.2 Ah	333 10.3 L	323 10.9 L	185032	*190819a*
332 8.0 Ah	324 8.8 Pt	R PAV	326 11.5 Pt	263 13.5 Ch	263 9.4 Ch
333 7.6 Gy	S OCT	*180863*	338 11.7 L	329[14.5 L	294 9.0 Ch
334 8.1 Ah	*172486*	292[11.9 En	SV DRA	S CRA	298 9.0 En
335 7.6 Jo	283 9.8 Bl	305[12.3 Ht	183149	*185437a*	299 9.1 Ht
339 8.1 Ah	292 10.5 Bl	T HER	330 10.3 L	283 11.9 Bl	305 9.3 Ht
341 8.3 Ah	299 10.9 Ht	180531	RZ HER	290 12.1 Sl	TY AQL
345 7.9 Pc	303 11.1 Bl	292 11.7 Jo	183225	292 11.9 En	*190907*
S HER	305 11.3 Ht	295 11.5 Jo	333 13.7 L	292 11.9 Bl	324 10.8 Pt
164715	311 11.1 Bl	301 10.5 Jo	X OPH	298 12.0 En	S LYR
341 11.8 Pt	328 12.1 Ht	303 10.5 Jo	183308	299 12.5 Ht	190925
	337 12.5 Ht	307 9.6 Jo	274 8.8 Ch	305 12.1 Ht	292 12.0 Ch
		321 8.7 Jo			302 12.0 Jo

VARIABLE STAR OBSERVATIONS RECEIVED DURING JANUARY, 1931.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
S LYR	Z SGR	R CYG	TU CYG	Z CYG	RW AQL
190925	*191321*	193449	194348	195849	200715b
322 11.9 B	292[12.4 En	351 11.7 Pc	326 11.0 Rs	293 11.5 Ch	333 9.3 Jo
326 11.8 Pt	SW SGR	351 10.5 Mc	328 10.5 Jo	302 11.0 Ch	R TEL
335 12.0 L	*191331*	352 10.6 Mc	329 11.0 Jo	326 8.9 Pt	*200747*
X LYR	292[12.4 En	RV AQL	329 10.8 L	329 9.1 L	293[13.5 Bl
190926	293[12.9 Bl	193509	335 10.7 Jo	S TEL	RU AQL
326 9.0 Pt	298[12.1 En	323 13.1 L	X AQL	*195855*	200812
RS LYR	TZ CYG	326 13.4 Pt	194604	293 13.0 Bl	296 11.8 Ch
190933a	191350	338 13.6 L	274 8.7 Ch	298 13.0 En	321 13.2 B
324 12.5 Pt	324 10.7 Pt	T PAV	296 10.0 Ch	299 12.8 Ht	323 13.1 L
329 12.1 L	U LYR	*193072*	323 11.3 L	SY AQL	338 13.8 L
RU LYR	191637	283 9.5 Bl	326 11.8 Pt	200212	W CAP
190941	291 10.8 Jo	292 9.5 En	326 11.3 B	296 10.4 Ch	*200823*
295 13.7 Ch	295 11.0 Jo	293 10.2 Bl	338 11.6 L	321 10.2 B	293[12.8 Bl
324 11.5 Pt	301 10.4 Jo	298 9.7 En	X CYG	323 10.3 L	Z AQL
329 10.3 L	321 11.0 Jo	299 11.0 Ht	194632	326 10.8 Pt	*200906*
345 10.6 Pc	324 11.5 Jo	303 10.8 Bl	263 7.9 Ch	338 10.6 L	326 13.4 Pt
U DRA	324 10.8 Pt	305 11.2 Ht	290 9.6 Ch	S CYG	R SGE
190967	326 11.2 Rs	311 11.3 Bl	295 10.6 Jo	*200357*	*200916*
263 10.2 Ch	331 11.5 Jo	328 12.3 Ht	301 10.6 Jo	275 13.0 Ch	291 9.4 Jo
294 11.0 Ch	335 11.8 Jo	337 12.6 Ht	304 10.7 Jo	296 12.4 Ch	295 9.8 Jo
324 11.5 Pt	AF CYG	RT CYG	308 10.4 Ch	304 11.9 Ch	301 10.0 Jo
330 12.3 L	192745	194048	326 10.5 Pt	326 11.5 Pt	303 10.3 Jo
W AQL	313 6.7 Ah	274 10.0 Ch	327 10.8 Bg	326 10.5 B	304 10.2 Jo
191007	316 6.8 Ah	291 9.0 Jo	352 11.7 Bg	326 11.3 Rs	307 10.3 Jo
263 12.4 Ch	330 7.3 Ah	293 9.2 Ch	RR SGR	329 10.6 L	321 10.0 Jo
294 9.0 Ch	331 7.4 Ah	295 8.6 Jo	*191939*	344 10.2 Pc	324 10.2 Jo
324 8.2 Pt	332 7.4 Ah	301 8.1 Jo	293 12.7 Bl	350 10.3 Gy	331 10.5 Jo
T SGR	334 7.4 Ah	303 8.0 Jo	298 12.8 En	R CAP	333 10.1 Jo
191017	339 7.4 Ah	307 7.6 Jo	RU SGR	*200514*	RS CYG
263 11.2 Ch	TY CYG	308 7.6 Ch	*195142*	296 10.7 Ch	200938
294 10.0 Ch	192928	315 7.3 Ah	283 6.9 Bl	323 11.6 L	263 7.1 Ch
R SGR	295 14.0 Ch	316 7.1 Ah	292 7.6 En	326 11.5 Pt	274 7.2 Ch
191019	329 13.3 L	321 7.2 Jo	293 7.1 Bl	S AQL	290 7.4 Ch
263 10.2 Ch	RT AQL	324 7.0 Jo	298 7.6 En	*200715a*	291 7.1 Jo
292 11.0 En	193311	326 7.3 B	299 6.8 Ht	290 9.8 Ch	292 7.2 Ch
298 11.5 En	263 10.4 Ch	328 7.0 Pt	302 7.0 Bl	291 9.9 Jo	296 7.2 Ch
299 11.5 Ht	296 11.3 Ch	328 7.1 Jo	305 6.7 Ht	295 9.8 Jo	301 7.0 Jo
305 11.6 Ht	323 12.8 L	329 7.0 Jo	311 7.2 Bl	301 10.0 Jo	303 7.2 Jo
RY SGR	324 12.5 Pt	330 7.2 Ah	RR AQL	303 10.0 Jo	303 7.2 Ch
191033	338 12.6 L	331 7.2 Ah	*195202*	304 10.3 Jo	307 7.2 Jo
263 13.4 Ch	R CYG	332 7.2 Ah	323 9.1 L	307 10.2 Jo	311 7.3 Ch
283[12.5 Bl	193449	334 7.3 Ah	326 9.2 Pt	321 11.2 Jo	321 7.2 Jo
293[13.0 Bl	263 8.9 Ch	335 7.3 Jo	339 9.2 L	324 11.0 Jo	324 7.1 Jo
298[12.5 En	290 9.7 Ch	339 7.3 Ah	RS AQL	326 11.4 Pt	326 7.0 Pt
303[12.5 En	291 9.2 Jo	344 6.9 Pc	*195308*	331 11.6 Jo	329 7.1 L
305[12.5 Ht	295 9.6 Jo	350 6.9 Gy	323 13.9 L	333 11.6 Jo	331 7.0 Jo
311[12.1 Bl	301 9.7 Jo	351 7.0 Pc	NOV CYG	RW AQL	332 7.5 GD
TY SGR	303 9.8 Jo	TU CYG	195553	200715b	335 7.1 Jo
191124	307 9.8 Jo	194348	326[12.9 Rs	291 9.1 Jo	351 7.5 GD
292[12.2 En	308 7.6 Ch	291 10.5 Jo	349[12.2 Pt	295 9.0 Jo	R DEL
293 12.5 Bl	321 10.5 Jo	301 10.5 Jo	351[12.2 Pt	301 9.1 Jo	201008
302[12.4 Bl	324 10.5 Jo	303 9.9 Jo	RR TEL	303 9.3 Jo	321 9.7 B
S SGR	326 9.5 Pt	307 10.2 Jo	*195656*	304 9.3 Jo	323 9.6 L
191319a	328 11.0 Jo	308 11.2 Ch	298[12.6 En	307 9.5 Jo	326 9.8 Pt
263 13.6 Ch	329 10.9 Jo	321 10.0 Jo	305[12.6 Ht	321 9.7 Jo	332 9.3 Ah
283[12.2 Bl	335 11.0 Jo	324 10.4 Jo	Z CYG	324 9.2 Jo	338 8.9 L
305[12.7 Ht	344 11.3 Pc	326 10.5 B	195849	326 9.1 Pt	
	350 10.9 Gy	326 11.0 Pt	275 12.8 Ch	331 9.2 Jo	

VARIABLE STAR OBSERVATIONS RECEIVED DURING JANUARY, 1931.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RT CAP	ST CYG	U CAP	X CAP	X PEG	R GRU
201121	202954	*204215*	*210221*	211614	*214247*
326 7.0 Pt	322 13.8 B	293[13.5 Bl	326 11.8 Pt	343 9.7 B	305 13.0 Ht
SX CYG	326 12.9 Rs	329 12.1 L	X CEP	345 9.6 Pc	328 11.9 Ht
201130	326 13.5 Pt	V DEL	210382	T CAP	338 10.3 Ht
321 13.5 B	333 13.9 L	204318	303[12.1 Ch	*211615*	V PEG
329 13.3 L	V VUL	304 13.6 Ch	330 14.3 L	293 12.9 Bl	215605
RT SGR	203226	335 13.8 L	RS AQR	303 12.5 Bl	304 12.6 Ch
201139	326 9.1 Pt	T AQR	*210504*	304 12.7 Ch	305 12.1 Md
283 10.7 Bl	R MIC	*204405*	312 11.1 L	312 11.8 L	322 11.3 B
293 11.0 Bl	*203429*	291 12.0 Jo	326 11.5 Pt	335 10.4 L	326 11.0 Pt
303 11.4 Bl	283 10.6 Bl	304 12.8 Ch	335 11.4 L	S MIC	335 11.2 L
WX CYG	293 11.6 Bl	326 13.5 Pt	Z CAP	*212030*	343 9.9 B
201437b	303 11.9 Bl	RZ CYG	*210516*	283 9.7 Bl	U AQR
275 12.1 Ch	Y DEL	204846	326 13.8 Pt	292 9.8 En	*215717*
296 12.5 Ch	203611	322 12.0 B	R EQU	293 10.1 Bl	326 13.2 Pt
322 12.7 B	274 11.0 Ch	326 12.1 Pt	210812	298 10.3 En	329 14.5 L
326 12.3 Rs	295 11.2 Ch	S IND	312 10.4 L	303 10.1 Bl	RT PEG
326 13.0 Pt	321 11.5 B	*205954*	326 11.9 Pt	Y CAP	215934
329 12.2 L	323 11.5 L	283 11.5 Bl	335 12.5 L	*212814*	321[14.0 L
V SGE	326 11.5 Pt	293 12.0 Bl	T CEP	293[13.1 Bl	339[14.0 L
201520	329 11.9 L	299 12.2 En	210868	304[13.2 Ch	RY PEG
312 11.7 L	S DEL	299 12.2 Ht	273 6.9 Ch	329 14.5 L	*220133a*
319 12.5 L	203816	305 12.9 Ht	292 6.7 Ch	W CYG	322 12.3 B
321 12.4 L	295 11.6 Ch	X DEL	295 6.0 Jo	213244	RZ PEG
323 12.4 L	321 10.5 B	205017	301 5.9 Jo	319 5.6 L	*220133b*
330 12.0 L	326 11.0 Pt	304 9.8 Ch	302 6.6 Ch	325 5.8 L	322 11.8 B
333 13.0 L	V CYG	312 9.3 L	304 6.3 Jo	335 5.8 L	325 12.1 L
335 12.6 L	203847	326 8.5 Pt	308 6.4 Ch	S CEP	326 11.6 Pt
338 12.3 L	273 9.0 Ch	335 8.7 L	313 6.0 Ah	213678	T PEG
339 12.2 L	296 9.0 Ch	R VUL	315 6.2 Ah	274 9.4 Ch	*220412*
U CYG	301 10.0 Jo	*205923a*	321 6.5 Jo	312 10.1 Ch	335 12.2 L
201647	307 9.8 Jo	296 9.5 Ch	326 6.2 Pt	326 9.0 Pt	350 11.3 Gy
195 8.2 Jb	322 9.2 B	301 8.7 Jo	328 6.2 Jo	350 10.7 Md	Y PEG
291 7.5 Jo	326 10.0 Sf	304 8.7 Jo	328 6.2 Gy	RU CYG	*220613*
296 7.5 Ch	326 9.1 Pt	307 8.6 Jo	330 6.1 Ah	213753	330 13.9 L
301 7.5 Jo	329 10.1 L	321 7.3 B	331 6.2 Ah	313 8.7 Ah	RS PEG
303 7.1 Jo	338 10.1 Sf	321 7.4 Jo	331 6.3 Jo	326 8.8 Pt	*220714*
307 7.2 Jo	344 9.5 Pc	324 7.5 Jo	334 6.2 Ah	330 8.7 Ah	330 13.2 L
321 7.2 Jo	349 10.0 Sf	326 7.2 Pt	335 6.3 Ah	331 8.8 Ah	T GRU
322 7.0 B	Y AQR	331 7.4 Jo	335 6.2 Jo	334 9.0 Ah	*221938*
324 7.1 Jo	*203905*	331 7.7 Ah	339 6.3 Ah	339 8.9 Ah	292 11.0 En
326 7.1 Pt	274 9.2 Ch	332 7.8 Ah	341 6.4 Ah	353 9.1 Bw	298 11.0 En
328 7.4 Jo	291 9.0 Jo	334 7.9 Ah	350 6.6 Gy	RV CYG	S GRU
332 7.2 Jo	295 8.8 Jo	335 7.2 Jo	RR AQR	213937	*221948*
332 7.6 GD	301 8.6 Jo	339 8.1 Ah	*210903*	326 6.3 Pt	292 12.7 En
335 7.1 Jo	302 9.0 Ch	V CAP	326 13.4 Pt	RR PEG	298 12.8 En
338 7.6 Sf	326 9.8 Pt	*210124*	329 13.6 L	214024	303 13.4 En
349 7.5 Sf	T DEL	283 10.0 Bl	Y PAV	304 9.4 Ch	RV PEG
351 7.8 GD	204016	293 9.4 Bl	*211570*	305 9.8 Md	222129
358 8.0 Mc	295 13.2 Ch	303 9.8 Bl	299 6.0 Ht	322 10.7 B	335 13.4 L
U MIC	326 12.4 Pt	TW CYG	305 5.6 Ht	326 11.0 Pt	354 12.0 Fe
202240	329 11.7 L	210129	328 5.8 Ht	350 11.8 Md	S LAC
293 13.4 Bl	V AQR	295[13.2 Ch	338 5.5 Ht	R GRU	222439
Z DEL	204102	326[13.9 B	X PEG	*214247*	325 7.4 L
202817	326 9.8 Pt	333 14.9 L	211614	292 13.3 En	326 7.0 Pt
323 13.6 L	329 9.1 L	X CAP	312 10.4 L	293 13.3 Bl	326 7.6 B
338 13.9 L	W AQR	*210221*	322 10.3 B	298 13.3 En	350 7.8 Md
	201104	293 11.9 Bl	326 10.7 Pt	303 12.8 Bl	
	329 13.3 L	303 10.7 Bl	333 9.9 L	304 12.9 En	

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R IND	β PEG	S PEG	ST AND	Z CAS	R CAS
222867	225827	231508	233335	233956	235250
283 12.5 Bl	349 2.7 Mc	321 11.6 B	347 10.4 Mg	307[13.1 Ch	307 10.4 Ch
293 13.0 Bl	358 2.6 Mc	325 12.5 L	348 10.5 BL	325 14.2 L	326 9.0 B
299 13.5 Ht	R PEG	326 11.5 Pt	350 10.7 BL	349[13.4 Mg	328 9.4 Gy
303 13.5 Bl	230110	343 11.5 B	352 10.5 BL	RR CAS	330 9.4 Ah
337[13.5 Ht	296 10.5 Ch	347 11.2 Mg	355 10.3 BL	235053	331 9.5 Ah
T TUC	326 11.4 Pt	V PHE	R AQR	349 12.1 B	334 9.4 Ah
223462	350 12.0 Gy	*232746*	*233815*	354 11.7 Fe	341 9.2 Ah
298 13.6 En	V CAS	298[12.7 En	273 8.6 Ch	359 11.6 Bn	350 8.6 Gy
299 13.1 Ht	230759	305[13.2 Ht	283 8.3 Bl	V CET	Z PEG
305 13.1 Ht	274 7.6 Ch	337[13.2 Ht	290 8.6 Ch	*235209*	235525
328 12.3 Ht	293 8.1 Ch	Z AND	293 8.7 Bl	274 10.4 Ch	307 12.9 Ch
337 11.3 Ht	303 8.5 Ch	232848	295 8.8 Jo	283 10.0 Bl	325 12.4 L
R LAC	326 9.8 Pt	326 10.0 Pt	298 8.7 En	293 10.2 Bl	326 12.6 Pt
223841	330 10.0 Ah	349 9.4 Bg	299 8.3 Ht	303 11.1 Bl	350 11.2 Gy
305 13.2 Ch	331 10.0 Ah	350 9.8 Md	301 8.6 Jo	303 11.0 Ch	W CET
325 14.3 L	334 10.2 Ah	ST AND	303 8.9 Bl	325 12.1 L	*235715*
326 13.2 Pt	343 10.2 B	233335	304 8.6 Jo	348 13.0 Mg	273 9.3 Ch
RW PEG	W PEG	305 11.0 Ch	305 8.3 Ht	R TUC	303 9.9 Ch
225914	231425	326 10.9 Pt	325 8.7 L	*235265*	Y CAS
296 9.5 Ch	305 11.8 Ch	326 11.0 BL	326 8.7 Pt	298 9.7 En	235855
325 10.1 L	325 11.7 L	338 10.7 BL	328 8.9 Ht	299 9.5 Ht	307 13.0 Ch
326 10.0 Pt	S PEG	341 10.7 BL	338 9.1 Ht	305 10.8 Ht	310 13.1 Kz
339 10.8 L	231508	343 10.0 B	339 8.9 L	328 12.2 Ht	325 13.1 L
341 10.5 Sf	305 13.0 Ch			337 12.6 Ht	SV AND
343 10.8 B					235939
349 11.3 Sf					310 13.2 Kz
359 11.9 Ma					326 12.5 Pt
					349 12.3 B

RAPIDLY VARYING IRREGULAR VARIABLES.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
005840	RX ANDROMEDAE—			
	6275.1	11.7 Ch	6330.4	11.7 L
	6291.1	11.0 Ch	6334.6	13.0 Pt
	6307.2	12.8 Ch	6335.4	13.1 L
	6312.2	11.3 L	6337.3	13.1 L
	6319.5	12.9 L	6338.3	10.8 L
	6321.2	13.0 L	6339.3	12.2 L
	6326.7	10.9 Pt	6349.6	13.1 Pt
	6327.6	11.6 Pt	6350.6	13.0 Pt
	6328.2	11.0 L	6351.6	12.3 Pt
	6328.6	11.5 Pt	6352.6	10.8 Pt
	6329.3	11.1 L		
060547	SS AURIGAE—			
	6275.2	[13.3 Ch	6330.4	14.3 L
	6295.2	[13.9 Ch	6330.7	14.3 L
	6303.1	[11.6 Ch	6333.3	14.3 L
	6307.2	[13.3 Ch	6334.6	[12.6 Pt
	6310.8	[12.5 Kz	6337.7	14.2 L
	6313.5	[12.4 Ch	6338.3	14.4 L
	6319.3	11.1 L	6339.3	14.5 L
	6321.2	11.6 L	6341.6	[12.4 Pt
	6322.7	12.4 L	6348.6	[13.0 Mg
	6323.3	12.6 L	6349.6	14.2 B
	6325.4	14.2 L	6350.6	[12.6 Pt
	6326.6	[12.5 Rs	6351.6	13.5 Pt
	6327.6	[12.6 Pt	6352.6	11.4 Pt
	6228.2	14.5 L	6354.7	11.6 Fe
	6329.4	14.3 L		

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
074922	U GEMINORUM—			
	6294.2	11.7 Ch	6331.9	[13.3 Ma
	6305.2	13.8 Ch	6333.3	14.0 L
	6310.9	13.6 Kz	6337.4	14.0 L
	6313.5	[12.3 Ch	6337.7	14.1 L
	6321.4	13.8 L	6339.3	13.8 L
	6322.7	13.9 L	6341.6	[13.3 Pt
	6325.4	13.8 L	6349.7	[11.2 Pt
	6326.1	13.8 Sl	6350.7	[13.3 Pt
	6328.7	14.0 L	6351.6	[13.3 Pt
	6329.7	14.0 L	6352.6	[12.4 Pt
	6330.4	14.1 L	6352.6	[13.3 Bw
	6330.7	14.0 L		
081473	Z CAMELOPARDALIS—			
	6310.9	11.8 Kz	6329.4	11.4 L
	6312.2	11.8 L	6329.7	11.0 L
	6319.3	12.7 L	6330.3	11.0 L
	6321.2	13.0 L	6330.7	11.0 L
	6322.7	12.8 L	6333.3	11.3 L
	6323.3	13.0 L	6337.4	11.6 L
	6325.4	12.9 L	6338.3	12.3 L
	6328.2	12.1 L	6339.3	12.3 L
094512	X LEONIS—			
	6322.7	[12.3 L	6330.7	[14.7 L
	6328.7	[14.0 L	6333.4	[13.3 L
	6329.7	[14.0 L	6337.7	[14.0 L

VARIABLE STAR OBSERVATIONS RECEIVED DURING JANUARY, 1931.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
202946 SZ CYGNI—				
	6326.6	8.9 Pt	6344.6	9.3 Pt
	6327.6	9.2 Pt	6349.6	9.6 Pt
	6328.6	9.2 Pt	6350.6	9.3 Pt
	6334.6	9.0 Pt	6351.6	9.2 Pt
	6341.6	9.0 Pt	6352.6	9.0 Pt
213843 SS CYGNI—				
	6239.8	9.8 Jb	6321.3	12.1 L
	6272.1	8.6 Ch	6321.6	11.2 B
	6275.2	9.5 Ch	6321.6	11.8 Jo
	6292.1	11.8 Ch	6322.6	10.6 B
	6295.2	11.9 Ch	6323.3	10.4 L
	6301.7	12.0 Jo	6324.6	9.4 Jo
	6303.1	11.8 Ch	6325.3	9.2 L
	6303.7	11.6 Md	6325.5	8.9 Sf
	6304.7	12.0 Jo	6326.5	8.4 Sf
	6307.1	11.9 Ch	6326.6	8.4 B
	6310.7	11.9 Kz	6326.7	9.0 Pt
	6312.2	12.1 L	6327.6	8.9 Pt
	6319.3	12.1 L	6328.3	8.7 L
213843 SS CYGNI—				
	6328.6	8.9 Jo	6338.3	12.0 L
	6328.6	9.0 Pt	6339.2	12.1 L
	6329.3	8.7 L	6339.3	11.8 Ah
	6329.6	9.0 Jo	6341.6	11.7 Pt
	6330.2	9.0 Ah	6343.5	12.0 B
	6330.3	9.1 L	6344.6	11.6 Pc
	6330.4	9.1 Ah	6344.6	11.7 Pt
	6331.2	9.2 Ah	6345.6	11.7 Pc
	6331.6	9.5 Jo	6347.5	11.3 Wd
	6331.7	9.5 Ma	6347.6	11.8 Mg
	6332.2	9.5 Ah	6348.6	11.9 Mg
	6332.6	10.0 Jo	6349.6	11.7 Mg
	6333.3	10.2 L	6349.6	11.7 Pt
	6334.3	10.6 Ah	6349.6	11.8 Pc
	6334.5	11.5 Pt	6350.6	11.7 Pt
	6334.6	11.3 Jo	6351.6	11.7 Pt
	6335.2	10.9 L	6351.6	11.9 Pc
	6335.3	10.7 Ah	6352.6	11.5 Wd
	6335.6	11.6 Jo	6352.6	11.6 Pt
	6337.3	11.5 L	6354.7	11.3 Fe

SUMMARY FOR THE MONTH OF JANUARY, 1931.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Ahnert	Ah	35	160	Kurtz	Kz	13	13
Allen	Al	8	8	Lacchini	L	184	320
Baldwin	Bl	76	144	McLeod	Mc	9	17
Bigelow	Bw	12	15	Marsh	Ma	33	48
Boutell	BL	10	59	Millard	Md	11	13
Bouton	B	40	48	Monnig	Mg	14	14
Brown	Bn	4	20	Peltier	Pt	197	252
Bunting	Bg	3	4	Proctor	Pc	22	28
Chandra	Ch	164	274	Ross	Rs	7	7
Ensor	En	58	88	Shinkfield	Sl	24	91
Ferris	Fe	8	8	Smith, F. W.	Sf	13	30
Godfrey Club	GD	3	6	Wares	Ws	6	13
Gregory	Gy	19	24	Webb	Wd	3	6
Houghton	Ht	72	204				
Jacobsen	Jb	3	3	Totals		29	415	2300
Jones	Jo	65	383				

receive an unexpected call from him in the course of his wide ramblings.

Secretary Olcott, who for the past year or more has been seeking renewed health in the West, has taken up a new residence, for a few months at least, at El Conquistador in Tucson, Arizona, and is somewhat improved in health.

R Scuti has been undergoing rather peculiar variations during the past year, somewhat similar to those evidenced in 1921. The completeness of the observations indicates the close attention which A.A.V.S.O. members have given this star in recent years. SU Tauri is again on the rise to maximum, and RY Sagittarii should be closely followed as soon as it becomes available for observation, in order that its rise to maximum may not pass unobserved. R Coronae Borealis also demands close attention.

LEON CAMPBELL, Recording Secretary.

February 11, 1931.

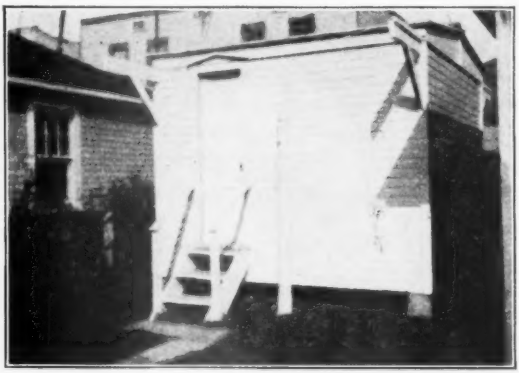
NOTES FROM AMATEURS

Building An Observatory

Here are some pictures of my second observatory which I built this summer, on my vacation, to house a 5½-inch refractor.

I watched with interest the descriptions and pictures of private observatories published in POPULAR ASTRONOMY this year and I finally adopted the general principle used by Mr. T. C. H. Bouton of St. Petersburg, Florida, that is, the sliding roof.

The inside dimensions are 10 feet square and 6 feet 6 inches high to the plate forming the track. The floor is of wood two feet from the ground supported on



FRONT VIEW OF FINISHED OBSERVATORY.

2x6 joists which carry the load to the four 8x8 corner posts of reinforced concrete. The frame is 2x4 studs 24 inches apart with 2x4 corner braces and plate with the exception of the side plates which are 2x6 pieces 16 feet long running right through in one piece and projecting three feet front and back; this acts as the track for the roof. The sides of this frame are covered with white pine novelty siding.

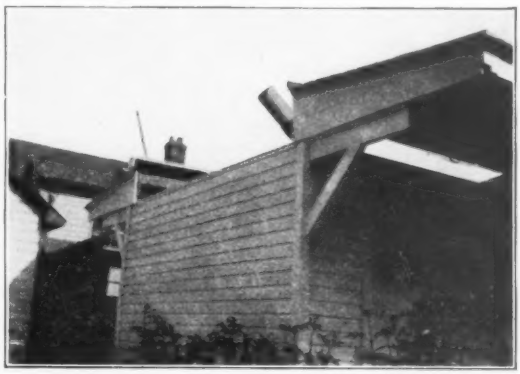
The roof is a 2x4 frame work with the exception of the two ridge pieces which are 2x6. This frame is covered with shiplap and two-ply roofing paper. The ridge joint is made watertight by a 6-inch overlap above the ridge pieces. Each half of the roof has four 2½-inch stock truck rollers with 1¼-inch face bolted to the roof framing, the two rollers on the front and rear set back two feet to give it the necessary overhang as the 2x6 track piece projects 36 inches and the roof projects 24 inches past the end of the track piece, giving the necessary 60 inches required for the roof to leave a clear 10 feet square opening inside.

The telescope and stand are also home-made with the exception of the objective which is of 5½-inch aperture, 85-inch focus, by Fitz. The tube is 6-inch galvanized iron, attached to an equatorial mounting made of 2-inch pipe fittings with brass bushings supported on a wooden tripod.

The tripod is made of 2x3 material bolted together and resting on three 8x8 reinforced concrete piers which were located in their proper positions and pass

through the framing of the floor independent of the building and tied together by a pipe frame below the floor.

The sliding roof works well and with the large opening my attention is sometimes taken from the object I am observing to see a darting meteor. If the night is cold and breezy or a heavy dew falling, I leave one side of the roof closed to act as a shelter.



SIDE VIEW SHOWING FINISHED ROOF OPEN.

The instrument has proved to be very steady even in a slight breeze. On a fine night stars down to 12.5 magnitude have been glimpsed in this suburb of New York City.

The equipment is used chiefly to help carry on the program of Variable Stars for the A.A.V.S.O. and for celestial objects of my own interest, the powers used are

43×	85×	for Variable Stars.
170×	226×	for Planetary Detail.
	340×	for Close Double Stars.

H. B. WEBB.

9251 173rd Street, Jamaica, L. I., N. Y., November 11, 1930.

The Possibility of Error in the Early Records of the Color of Sirius

According to certain early astronomers, the color of Sirius was at one time red. To quote the *Encyclopaedia Britannica* (article, "Canis Major") on the subject: "At the present time its color is white with a tinge of blue, but historical records show that this color has not always prevailed. Aratus designated it as many colored; the Alexandrian Ptolemy classified it with Aldebaran, Antares, and Betelgeuse as fiery red; Seneca describes it as 'redder than Mars'; while in the tenth century the Arabian Biruni termed it 'shining red.' On the other hand, Sufi, who also flourished in the tenth century, pointedly omits it from his list of colored stars."

Now, the point is this. Are the early records to be trusted? If so, to what extent? Also, are there any facts known about stars or the early astronomers whereby we can test their statements about the color of Sirius? The author believes that there are certain facts whereby this can be done, and in this article will attempt to state and apply them.

In the first place, until the connection between the spectrum of a star and its color became apparent, owing to the researches of Secchi and Huggins, the color of a star was thought to be relatively unimportant by most astronomers. It would therefore be observed with little care, or maybe not noticed at all, or accepted from tradition or previous records. And it is to be remembered that up to the modern period, if an alleged fact of nature was thought to possess a religious or magical symbolism, there was generally difficulty, as well as some personal danger in putting it to the test of observation, and then, in changing the opinion of the general public. This is to be seen in so simple a matter as the color of the rainbow. By several authors during medieval times, the color of the rainbow is said to be green, red, and blue in the order named. Of course, this order was supposed to have mystical symbolism, green representing water; red, land; and blue, sky.

Similarly, the red color attributed by the ancients to Sirius most probably had a mystical symbolism attached to it. Red is the color of both blood and fire, and was also the color of mourning among the ancient Assyrians and Babylonians. The ancients regarded Sirius as responsible for the heat of summer and the sickness and death accompanying it. This belief is responsible for our expression, "dog days." Red would be a fitting color for the cause of heat, also for the cause of fever. So, there would be a strong tendency, for this reason, to give the color of Sirius as red.

With regard to the authorities mentioned in the first paragraph, Seneca was not an astronomer, and he sometimes borrowed his facts, from very poor authorities. It may also be said that of the two Arabians, Sufi is generally considered a better authority than Biruni.

It therefore becomes apparent that there are reasons why astronomers would have a tendency to regard Sirius as red, even though its color were white. We have also shown that where two contemporaneous authorities disagree, the better of the two agrees with recent observations, and does so in a manner that might indicate that he felt himself to be correcting an error. The term "many colored," applied to Sirius by Aratus may well refer to the apparent rapid changes in color exhibited by bright stars, particularly those of blue and white color, during times of bad seeing.

We now pass to the verdict of the modern theory of stellar diameters, luminosity, and temperatures. This strange as it may seem, indicates that Sirius could have been a red star only if it were about three magnitudes fainter than it is at present.

But Sirius has been regarded since prehistoric times as one of the brightest, if not the brightest star in the sky. Observations of brightness were made by the early astronomers in a much more accurate manner than those of color. Besides, brightness observations are less subject to error than those of color. It is therefore practically certain that the color of Sirius has always been white within historic times.

NOAH W. MCLEOD.

Christine, North Dakota.

Amateur Celestial Photography.—The accompanying photograph is the result of a curious experiment which may interest amateur astro-photographers. It was desired to obtain as wide an angular view as possible, with quick exposures, to photograph the sky as nearly as possible the way it appears to the naked eye.

For this purpose a pair of condensing lenses were removed from a projection lantern, suitably mounted and focussed for the blue-violet rays. The center of

the field includes a large area of fairly good definition.

The relative focus of the lens is about 3½ inches, so the speed is approximately f 0.9 (ratio of aperture to focal length). The lens is so fast that exposures of 4 minutes are ample to show the naked eye stars and slightly below. A very clear sky is necessary.

PHOTOGRAPH OF ORION BY LATIMER J. WILSON,
November 1, 1930. Exposure 4 minutes.

Such imperfect lenses may find service in the amateur's observatory, and perhaps have been tried by others. But I have never heard of anyone trying to make photographs through these thick condensing lenses.

LATIMER J. WILSON.

Box 63, Franklin, Kentucky, November 5, 1930.

Some Unpublished Astronomical Correspondence.—Recently while examining the St. John collection of Wordsworthiana in the library of Cornell University I found a manuscript letter, which will, perhaps, be of some interest to scientists, especially to astronomers. The letter was written at the Bridgewater Foundry, Patricroft, near Manchester, January, 1840, by James Nasmyth (1808-1890) to John Pringle Nichol (1804-1859).

A brief introduction to the correspondents will add interest to the letter. James Nasmyth was the younger son of Alexander Nasmyth, a famous eighteenth-century portrait and landscape painter, well known through his close friendship with Robert Burns, of whom he made two portraits; through his views of places described by Scott; and through his work as an architect which in no slight degree contributed to the beauty of Edinburgh. His son James became an engineer, justly famous for his many inventions, the most important of which was the steam hammer. He also won much fame for his labors in astronomy, both as an observer and as a maker of telescopes. His studies of the surface of the moon

and of the sun were of great importance. Although astronomy might be considered his avocation, it was a most absorbing one. In his Autobiography we find a most delightful account of his astronomical enthusiasm at about the time he wrote the letter to Professor Nichol:

> "But my most favorite pursuit, after my daily exertions at the foundry, was astronomy. There were frequently clear nights when the glorious objects in the heavens were seen in most attractive beauty and brilliancy. I cannot express the thoughts which the impressive grandeur of the stars, seen in the silence of the night, suggested to me, especially when I directed my telescope, even at random, on any portion of the clear sky, and considered that *each* star of the multitude it revealed to me was a sun, the centre of a system! . . . Nothing can convey to the mind in so awful and impressive a manner the magnificence and infinite extent of creation, and the inconceivable power of its Creator.
>
> ". . . How eager and enthusiastic I was in those days! Sometimes I got out of bed in the clear, small hours of the morning and went down to the garden in my night-shirt. I would take the telescope in my arms and plant it in some suitable spot where I might get a peep at a special planet or star then above the horizon. It became bruited about that a ghost was seen at Patricroft! A barge was silently gliding along the canal near midnight, when the boatman suddenly saw a figure in white. 'It moved among the trees with a coffin in its arms!' The apparition was so sudden and strange that he immediately concluded that it was a ghost. The weird sight was reported all along the canal, and also at Wolverhampton, which was the boatman's headquarters. He told the people at Patricroft on his return journey what he had seen, and great was the excitement produced. The place was haunted—there was no doubt about it! After all the rumor was founded on fact, the ghost was merely myself, in my night-shirt, and the coffin was my telescope, which I was quietly shifting from one place to another, in order to get a clearer sight of the heavens at midnight."

In 1849 Nasmyth invented the trunnion turn-table by means of which he could sit at the side of his telescope, observe and direct it with ease to any part ot the heavens without the danger of being mistaken for a ghost. Through his inventions and studies he became intimate with several of the great astronomers of his day, including William Lassell, Warren de la Rue, and Sir John Herschel.

Nasmyth's correspondent in the letter before us was John Pringle Nichol, regius professor of astronomy in the University of Glasgow. He was an inspiring teacher, an impressive lecturer, and a most prolific writer in his chosen field. His first two books: *Views of the Architecture of the Heavens* and *Phenomena of the Solar System* appeared in 1838, and were the immediate occasion of the letter from Nasmyth.

This casual and interesting contact of two great scientists has a striking parallel in the field of English literature. Thackeray when a young and inexperienced author and artist once sought unsuccessfully the task of illustrating the works of Charles Dickens. Whether Nasmyth's offer of a frontispiece was accepted by Professor Nichol I do not know. I have not a sufficient number of Nichol's books at hand to enable me to ascertain. Perhaps some one will care to find out. I transcribe the letter exactly as it is without alteration of spelling and punctuation.

> Proffessor Nichol
> Sir
>
> the exalted pleasure which I have felt in the repeated perusal of your two truly admirable works has made me desireous to express to you my most sincere gratitude, as a most humble and devoted worshiper of Nature, for the beautifuly clear and noble manner in which you have set

forth the most sublime Department of creation. Should the accompaning origional sketch which I have made out for your acceptance be thought worthy of such a destination I Shall then feel most truly happy in having succeeded in so far expressing the deep obligation which I, in common with all who love "the Simplicity of Truth," must ever feel toward one of its most able champions.

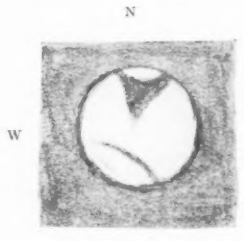
in the design of the sketch I have endeavored to represent the moment when the first Idea of the true Solar System gleamed forth in all its clearness on the master mind of "Copernicus." I only wish I had ability equal to my desire to do justice to a subject in every way so truly worthy of representation. Such as it is should it please please (sic) you I shall feel most happy indeed and Should you think it worthy of being reduced so as to act as the frontispiece to any of your future editions of "The Solar System" I would then feel most proud in having contributed my mite of practical testimony of the deep obligation which I shall ever feel towards you

trusting that you will excuse this intrusion
Believe Me Sir I am
Yours most Respectfully
James Nasmyth.

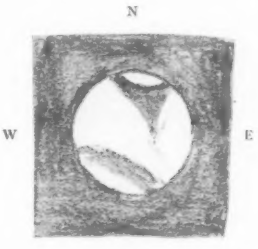
Bridgewater Foundry
Patricroft N Manchester
Jany. 1840

(Communicated by L. N. Broughton, Cornell University, Ithaca, N. Y.)

Drawings of Mars and Jupiter.—The accompanying sketches may interest some of the readers of POPULAR ASTRONOMY. They were made on the evenings of February second and third, using my 6-inch reflector with a power of 250X. The seeing was unusually good for this locality. The construction of this telescope,



MARS
FEB. 2, 1931.

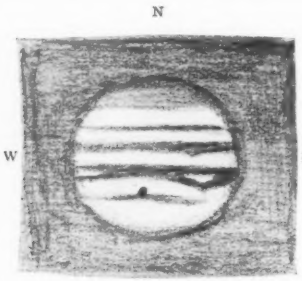


MARS
FEB. 3, 1931.

with stationary eyepiece, causing a double reflection, should be borne in mind in looking at the pictures.

The contrasting colors as seen on Mars were very beautiful. The polar cap was a brilliant bluish white and bordering this was a narrow band which looked very dark blue or gray. Extending down from this was a triangular area of lighter gray which faded at the southern tip into the brilliant orange of the greater portion of the disk. Across the southwesterly portion of the southern hemisphere was a grayish streak, concave towards the southwest. Between this streak and the edge of the disk the color had a slight bluish tinge.

The bands on Jupiter were very strongly marked. The south equatorial belt was divided into two portions at the west and east and between these two dark



JUPITER
FEB. 3, 1931.

lines were bright spots. The north belt was not divided but its southern edge was somewhat broken and irregular. The north polar regions were quite dark. Just north of the north equatorial belt was a much narrower and perfectly straight dark stripe.

HUGH G. BOUTELL.

3723 Jocelyn St., N. W., Washington, D. C., February 3, 1931.

THE ZODIAC OF DENDERA

Could It Have Been an Accident or Did They Know?

A short time ago Dr. James R. Withrow, head of the Department of Chemical Engineering of Ohio State University, and I were looking at a picture of the "Zodiac of Dendera"—the old stone ceiling of the Temple of Dendera, Egypt, which is now in the Louvre in Paris. It is estimated to be about 4000 years old, but the signs of the Zodiac carved on it are in the same order and the pictures of the same figures shown in our Almanacs today, though the figures representing most of the other Constellations are different. Dr. Withrow remarked that the figures shown were in the form of a helix. On a little closer scutiny we both decided the better word would have been spiral.

This at once suggested to me the beautiful pictures of the spiral nebulae our great observatories have lately been furnishing us and the theory often advanced that they may be island Universes and that if we could stand on some planet in them and look at our own Universe of stars, it would likely look much the same, with our sun and its planets only one of the many tiny specks sunk deep in the whirl.

If you look a little to the left of the center of the map you will see the Twins hand in hand; between Gemini and Leo you will find Cancer; following Leo, Virgo, then the Scales and the Scorpion, which you will find well out in the spiral: Sagittarius, Capricornus, Aquarius, and the Fishes followed by Aries and Taurus complete the zodiac as we know it, but not the spiral, for Taurus is followed by a figure of a man with something in his hand and this by something with a bird perched on top of it; next comes an ox, likely prepared for sacrifice, other figures follow which lead the eye to the final outer edge of the spiral.

Not being familiar with Egyptian symbols I can not name any of the ancient figures except these well-known Signs of the Zodiac which we find here, not in

the usual circle, but as part of this great spiral, though following each other in the usual order, but apparently beginning with the Twins.

The Zodiac of Denderah.

Why did those ancient Egyptians carve the map of the Constellations in the form of a great spiral? Had they any hint that our Universe might have that shape? If they knew, how did they know it?

FANNIE R. GASTON.
Assistant in Mathematics, Muskingum College, New Concord, Ohio.

ZODIACAL LIGHT NOTES

By W. E. GLANVILLE.

From Mr. I. L. Thomsen, Dominion Observatory, Kelburn, Wellington, New Zealand, has come information that the Zodiacal Light Section of the New Zealand Astronomical Society has been engaged on observations of the night luminosity of the sky of the South Pole area during the recent summer solstice. New Zealand is just north of the latitude of constant twilight in midsummer.

EVENING ZODIACAL LIGHT.—Mr. Stuart L. O'Byrne has sent reports of observations made on December 29, January 19 and 22 near Webster Groves, Mis-

scuri. On December 29 at 5:50 P.M. he found the Light beginning to show indistinctly; at 5:59 it was more distinct; at 6:05 the central part was brighter than the Milky Way in Cygnus. On account of moonlight only the stronger Light was visible, the apex being noted at Lambda Aquarii. On January 19 at 6:30 the Light was measured along the horizon between Delta and Beta Aquarii; the apex was about two degrees north of the ecliptic and about five degrees southwest of Delta Piscium. The boundaries were very diffuse; the main area of the Light was north of the ecliptic. On January 22 at 6:22 the base merged with the sunset glow and was estimated to be 24° in width. The blunt apex was traced from Theta Piscium around slightly north of 30 Piscium. The stronger Light was central along a line passing slightly north of Phi and Lambda Aquarii. During the time of observation, with the disappearance of the last vestiges of normal twilight, the Light stood out with increasing brightness surpassing the neighboring Milky Way. At 6:50 the apex was marked about eight degrees west of Eta Piscium, almost exactly on the ecliptic. Mr. Clinton B. Ford, Ann Arbor, Michigan, sent an observation report made on February 4 at his observatory, three miles southeast of the city. According to the diagram accompanying the report the apex of the stronger Light was found about five degrees east of Epsilon Piscium at 7:51 P.M. He adds: "The Light seemed to fluctuate but little and faded very quickly when it began to disappear."

The writer made observations on January 10, 13, 14, 15, 16, 17, 19, 21, February 4, 5, 6, 11. On all other nights clouds or moon interfered. On January 10 at 7:00 P.M. the Light was strong through Aquarius and Pisces, making on the horizon a striking acute angle with the Milky Way. At 9:45 the Square of Pegasus, sloping close to the horizon, was seen with its southern boundary almost entirely covered by the Light. The altitude of the Light was about the same as at 7:00 P.M. but the whole body of the Light was considerably fainter. At 7:00 P.M. the apex was just below Gamma Arietis; at 9:45 it was directly below the Pleiades, both asterisms having moved westward in the interval. On January 16 at 7:30 a cloud bar lying across the brightest section of the Light southeast of Markab appeared very dark by contrast with the remainder of the cloud beyond the Light eastward. On February 6 at 6:45 normal twilight was still faintly visible all over the Square of Pegasus. Between the north boundary of the Square and the Milky Way the sky was dark. At 7:15 the Square area was also dark and the south boundary of the Square was clear of the north boundary of the Light about three degrees. Also, Beta Ceti was clear of the south boundary about ten degrees. At 8:15 the Square was covered by the Light along its southern boundary and Beta Ceti was lost in the Light. As a general comment on all of the observations it may be said that the fact that the general dimensions of the Light during the past six weeks have been practically the same, but with luminosity decreasing as night progressed, may indicate a fading out rather than a setting of the Light.

Morning Zodiacal Light.—On January 18, while the sky was unsatisfactory because of scattered clouds below Libra to the horizon, at 5:50 A.M. the Light though quite faint was traced through Libra to Spica, the apex being about six degrees north of Spica.

Moon Zodiacal Light.—So far as known, all reports of the Moon Zodiacal Light have been of observations made of the eastern sky within a few nights after opposition before moonrise. On December 31 the writer made an observation of the western sky just before and after moonset, the moon then being in the second quarter and in the eastern part of Aries. Under exceptionally favorable conditions

the gibbous moon was found within three degrees of the horizon at 3:15 A.M. As the moon set, the Light extending from Perseus to Orion contracted until at 3:35 no moonlight reflection was visible except along the ecliptic from the horizon to the area between the Pleiades and the Hyades, the Pleiades being involved in it, the Hyades clear of it. In about five minutes the Pleiades stood out clear as the Light faded. Whether this lingering reflection be called moon twilight or moon Zodiacal Light the fact is that it was strictly within the Zodiacal zone.

GEGENSCHEIN.—During March the Gegenschein will be well placed for observation as it passes in front of Leo and Virgo. Any time between 10:00 P.M. and 2:00 A.M. will give a satisfactory view.

The Rectory, New Market, Maryland.

Observations of the Zodiacal Light

I have observed the Zodiacal Light in the village of Ustimovka (Long. $2^h\,13^m$ E; Lat. $+49°\,19'$) as follows:

1930, Oct. 2, $0^h\,35^m$ G.C.T. (3 hours 13 minutes before sunrise). The Zodiacal Light is faint, white. The highest point is near ϵ Cancri (68° west of the sun).

October 19. $1^h\,45^m$ (2 hours and 29 minutes before sunrise). The Zodiacal Light is white with hazy outlines. It is brighter than the Milky Way in Monoceros. The northern part is brighter than the southern part. The highest point is at $8^h\,06^m$, $+20°.5$ (87° west of the sun).

October 22. $1^h\,20^m$ (2 hours 57 minutes before sunrise). The Zodiacal Light is white with hazy outlines. The northern and southern parts are of equal brightness. The highest point is at $8^h\,25^m$, $+19°$ (85° west of the sun).

November 13. $16^h\,25^m$ (2 hours 15 minutes after sunset). The Zodiacal Light is faint with very hazy outlines. The highest point is north of λ Aquarii (117° east of the sun).

November 15. 16^h (1 hour 45 minutes after sunset). The Zodiacal Light is feeble, white with very hazy outlines. $19^h\,30^m$. The Gegenschein is visible. *A faint Zodiacal band extends between the Gegenschein and the western horizon.*

November 18. $2^h\,30^m$ (2 hours 32 minutes before sunrise). The Zodiacal Light is faint with hazy outlines. The highest point of the faint cone is near γ and η Leonis (89° west of the sun; 6° north of the ecliptic). The highest point of the bright cone is near η Virginis (54° west of the sun). Haze?

V. TSHERNOV.

Oktjabrskaja 77, Kremencug 2, Ukraine.

GENERAL NOTES

Dr. Adalbert Prey, formerly director of the observatory of the German University in Prague, has been appointed as professor of theoretical astronomy at the University of Vienna as successor to Professor S. Oppenheim.

Dr. Harlan T. Stetson, Professor of Astronomy at Ohio Wesleyan University and Director of Perkins Observatory, has been appointed Non-Resident Lecturer in the Graduate School of Ohio State University. This is in accordance with the plan approved by the Trustees of both Ohio Wesleyan and Ohio State University for the coöperative graduate program in Astronomy and Astrophysics, whereby graduate students of the State University may carry on research work for advanced degrees at the Perkins Observatory, Delaware, Ohio.

The British Association for the Advancement of Science, which was founded in 1831, and incorporated by Royal Charter in 1928, will hold meetings commemorating its Centenary, in London September 23-30, 1931.

American Astronomical Society Announcement.—The forty-sixth meeting of the American Astronomical Society, on the invitation of Professor Harlan True Stetson, will be held at the Perkins Obsevatory, Ohio Wesleyan University, Delaware, Ohio, September 7-8-9, 1931.

Royal Astronomical Society Awards.—The council of the Royal Astronomical Society has awarded its gold medal to Professor W. de Sitter, director of the Leiden Observatory, for his theoretical investigations on the orbits of the satellites of Jupiter, and his contributions to the theory of relativity. A Jackson-Gwilt Medal and Gift is awarded to Mr. Clyde W. Tombaugh, Lowell Observatory, Flagstaff, Arizona, in recognition of his discovery of Pluto. (*Science*, January 30, 1931.)

An International Conference on Calendar Simplification was placed on the agenda of the next General Conference on Communications and Transit, by the Assembly of the League of Nations, meeting this fall, with the United States participating, to take definite action to secure calendar improvement. This information was sent out by The World Calendar Association, Inc., 485 Madison Avenue, New York City.

The New Zealand Astronomical Society has an active section at work on star colors. This work is under the direction of Mr. A. G. C. Crust. A bulletin consisting of seven mimeographed pages was issued last November as the first annual bulletin. It contains the results of the observations made by the section up to the time of publication.

Note on the December Meeting of the E.B.A.A.A.—The Chabot Observatory at Oakland, California, sponsors an organization of amateur astronomers in the San Francisco Bay region known as the East Bay Amateur Astronomical Association, which meets the first Saturday of each month at the Chabot Observatory. Generally a professional astronomer is invited to speak at each meeting. There is an occasional variation, however, as at the December meeting. This meeting might have been called amateur telescope night. The folks who made or mounted telescopes were invited to bring them for exhibit. The success of the meeting was greater than was expected. There was one 3-inch refractor with a single element lens which was entirely home made. There were two refractors which have home made mountings; one is mounted equatorially* while the other is mounted on a combination ball and socket mounting. There were five home made reflectors ranging in size from four to ten inches. Two of the reflectors are Cassegrainian. Since the Cassegrainian is rather unusual in the home made telescope they attracted considerable attention.

The association is sponsoring work in several fields of astronomy by means of sections. Mr. Skaggs a well-known Oakland amateur astronomer is heading some of these sections including, of course, the variable star section. The telescope-

*This particular instrument was mounted by Mr. F. B. Wright of Berkeley. A picture of this instrument and a description by Mr. Wright of the mounting appeared in a recent number of the *Scientific American*.

making section, to which the December meeting was devoted, is headed by Mr. F. B. Wright of Berkeley. At the meeting mentioned Mr. Wright gave an illustrated lecture on the optics and design of telescopes with particular reference to mirrors.

United States Civil Service Examinations.—The United States Civil Service Commission announces the following-named open competitive examinations: Physicist, $3,800 a year; Associate Physicist, $3,200 a year; Assistant Physicist, $2,600 a year.

The optional subjects are: Heat, electricity, mechanics, light, radio, physical metallurgy, thermodynamics and aerodynamics, and any specialized work in the field of physics not included in any of the above. Applications for the above-named positions must be on file with the United States Civil Service Commission, Washington, D. C., not later than March 25, 1931.

BOOK REVIEWS

La Planète Mars, by E. M. Antoniadi. (Libraire Scientific Hermann et Cie, Paris. 224 pp. small 4 to 10 plates and many illustrations. Price 80 francs.)

This volume by Antoniadi is a real contribution to Martian literature. In it he gives not only the general facts concerning the planet but devotes approximately two-thirds of the book to a detailed description of the topography. The various features are dealt with in historical fashion and in the light of his own observations which extend over many oppositions.

M. Antoniadi has some very decided opinions concerning certain of the Martian features, especially the canals. He does not believe in these at all and devotes an entire chapter to "L'illusion des canaux."

The many illustrations in the text and the fine plates make the volume easy to read. It can be recommended to anyone interested in the Martian problem whether agreeing with the author or not. E.A.F.

A Manual of Celestial Photography, by Edward Skinner King. (Eastern Science Supply Co., Boston. 168 pp. 12 mo.)

The author of this little book is Professor King of the Harvard College Observatory. He has worked in the field of celestial photography for many years and is an authority on the subject. This volume gives the results of his long experience.

The subjects treated are shown by the following chapter headings: General survey; First principles; How to take an astronomical photograph; Keeping a record of photographic work; Adjustment of the telescope; What clock rate?; How to test the action of worm or driving screw; Guiding; Types of mounting; The photographic plate; What plate to use; The dark room and its equipment; Development and handling of plates; Photography of stellar spectra; Printing and enlarging; The amateur and his telescope; Subjects for photographic observation; Action of light on a photographic plate; Magnitudes, wedges, and color scales; Photometry of stellar images; Methods of measuring the images; Observational and laboratory practice for the student.

The book can be read with profit not only by the amateur but also by the professional astronomer. It will be especially valuable to those who would like to

take astronomical photographs but do not know how to begin the work and to students of practical astronomy in colleges and universities. In the opinion of the reviewer it is the best elementary book on the subject which has come to his notice. E.A.F.

The North American Almanac for 1931. (The North American Almanac Co., Chicago. Price 25 cents.)

This issue of "The Aristocrat of Almanacs" appeared after the opening of the year. It follows the plan of its predecessors in that it contains, in addition to the usual material found in almanacs, that is to say, the times of sunrise and sunset, the times of the moon's phases, etc., a number of interesting articles on a wide range of topics. Among its contributors are men who are well known and recognized authorities in their fields. It is doubtful whether so much good reading material can be secured anywhere else for the small price of this volume of more than two hundred pages.

Astronomy, Second Edition Revised, by John Charles Duncan. (Harper and Brothers, New York City. Price $3,75.)

The first edition of this popular textbook for college classes in astronomy was issued in August, 1926. It was reviewed in the February (1927) issue of this magazine. The new revised edition appeared early in 1930. The book is slightly increased in size, from 375 pages to 422 pages. Much of the material of the first edition was rewritten and some new material, notably an account of the discovery of Pluto, was added. The star charts, which in the first edition were the usual black stars and white sky diagrams, are more artistic and more suggestive, being white stars in a blue sky. About four hundred stars are included. Another added feature which impresses one as especially valuable is the review and application of principles induced by a list of questions at the close of each chapter.

The book unquestionably merits the favorable reception which has been accorded it by many teachers of astronomy.

Probabilités et Statistiques, by R. de Montessus de Ballore. (J. Hermann and Co., Paris, France. 60 fr.)

This volume of 211 pages bearing 1931 as the date of publication has recently been received. Although it is not astronomical in character, nevertheless we are pleased to call attention to it in these pages, because the theory of probability and the application of statistics are so frequently employed in present day investigations in all fields. The author and publisher are both so favorably known as to insure the work to be of a high grade. The work begins with the simplest ideas and proceeds to the more intricate parts of these subjects. For all who are interested in applying these principles in their investigations, even though they are not Frenchmen, the probability is quite near to unity that they will not be seriously deterred from using this book, for French is well nigh a universal language, and a mathematical work in French is even still more nearly universally understood among mathematicians.

Man and the Stars, by Harlan True Stetson. (Whittlesey House, McGraw-Hill Book Company, New York City. Price $2.50.)

This book, as its name implies, has much to say about the stars. However, one would make a great mistake in coming to the conclusion that it is therefore just another book on astronomy. It is one of the first books to be published by

Whittlesey House, a branch of the McGraw-Hill Book Company which is to publish non-technical books only, a field not entered hitherto by this Company. In the first place then we have the publishers' assurance that the book is intended for the lay reader. But again this fact does not indicate that it is unsuited to those who may already have given some attention to the stars. New ideas are being developed in astronomy so rapidly that even the professional astronomer must read at least one new book each year to keep abreast of the times. Here is a book which is modern and authentic and at the same time within the reach of any intelligent person. This book not only states facts but furnishes a new outlook on life.

By giving prominence to the personalities who have brought the science from its simple beginnings to its present stage of development, the author has infused life into what otherwise would be merely a compilation of information. By a judicious selection of material he has covered a wide range of knowledge in a book of moderate proportions.

The last one of the four sections, into which the book is divided, is especially to be commended. Here three questions are considered, viz. Is there Life on Other Planets? Has Life any Cosmic Significance? and Has Science Displaced Religion? These questions are repeatedly and insistently asked. Many times, it is true, the meaning of the question itself is not clear; that is, the questioner is not always aware of the full implication of the question. The book does not answer these questions categorically. They cannot be so answered. But the reader is given a better grasp of the significance of the question. He must deduce an answer for himself.

As one concludes the reading of this book he sees some significance in the fact that in the title the two principal words "man" and "stars" are printed in the same type. He feels that, although in size man is negligible in comparison with the stars, man is not therefore necessarily of less consequence than the stars.

This book merits reading and rereading.

Heaven and Earth, A Modern Astronomy, by Oswald Thomas. (W. W. Norton and Co., 70 Fifth Avenue, New York City.)

This is one of the many books which have recently appeared purporting, and in most cases succeeding, to explain in simple terms the views held at present by those who have brought expert methods to bear in an attempt to understand the universe in which we live. The author was formerly in charge of the Urania Observatory, Vienna, and presumably the book, to a large extent, is a compilation of the material used in connection with this position. The copy before us is an English translation by Bernard Miall.

The book is divided into ten chapters in more or less the traditional manner. The style is clear and, even though the reader is already familiar with the facts presented, the attention is held because of the aptness and freshness of the manner of presentation. One can easily imagine the delight of an eager and inquiring mind, but one unfamiliar with astronomical lore, in coming upon a book of this kind.

One or two features might be improved, at least so in the translated edition. For example the contents contain the item "Saro's period" (Saros).

The concluding chapters entitled "Where does the universe end," is especially worthy of careful reading. By well conceived analogies many of the points which are so perplexing to the beginner are made clear and vivid. However, so rapidly are ideas changing at present that even in the brief period since the publication of

this book some important modifications have appeared and have been generally adopted.

The book, as it seems to the reviewer, is well qualified to fill the purpose for which it is intended.

Katalog und Ephemeriden Veränderlicher Sterne für 1931, by R. Prager.

This is called number 9 of the minor publications of the University Observatory at Berlin-Babelsberg. However, it consists of 133 closely packed pages, and is an almost indispensable aid to those observers who are concerned with the study of Variable Stars. The first section consists of a catalog and ephemeris of long-period variables arranged according to constellations, and occupies 91 pages. The second section contains the elements of stars whose periods are less than 100 days, also arranged by constellations. Sections three and four contain similar lists of stars of the Algol-type and β Lyrae-type, respectively. Section five is a catalogue of variable stars arranged according to right ascension. A total of 4581 stars is listed.

This pamphlet is the best source available for up-to-date information concerning this interesting and important class of celestial objects.

Délimitation Scientifique des Constellations, by E. Delporte. (Cambridge University Press.)

This is a large sized book of forty-one pages of description and twenty-six pages of charts. It is the report of Commission 3 of the International Astronomical Union. In the descriptive pages the several constellations are definitely outlined by straight lines always coinciding with hour circles or parallels of declination. Fifty lines are needed to define Draco. The charts show these lines drawn among the stars of the constellations.

The purpose of thus more precisely defining the boundaries of the constellations is easily seen. Without it ambiguity frequently arises and leads to confusion. The work will be useful especially for reporting observations of meteors, for correctly designating variable stars and novae, etc. The lines marking out the constellations have been chosen so as to disturb existing nomenclature as little as possible. The Commission is to be commended for so systematic and so thorough a piece of useful work.

Correction.—Professor William H. Pickering wishes to correct the impression given in the last paragraph of his "Summary" on page 2 of the January (1931) issue. He has since learned that Dr. Crommelin gave a very nearly correct orbit of Pluto in *B.A.A. Circular* 93, published on May 19, 1930, and an accurate orbit at a meeting of the British Astronomical Association on June 25.